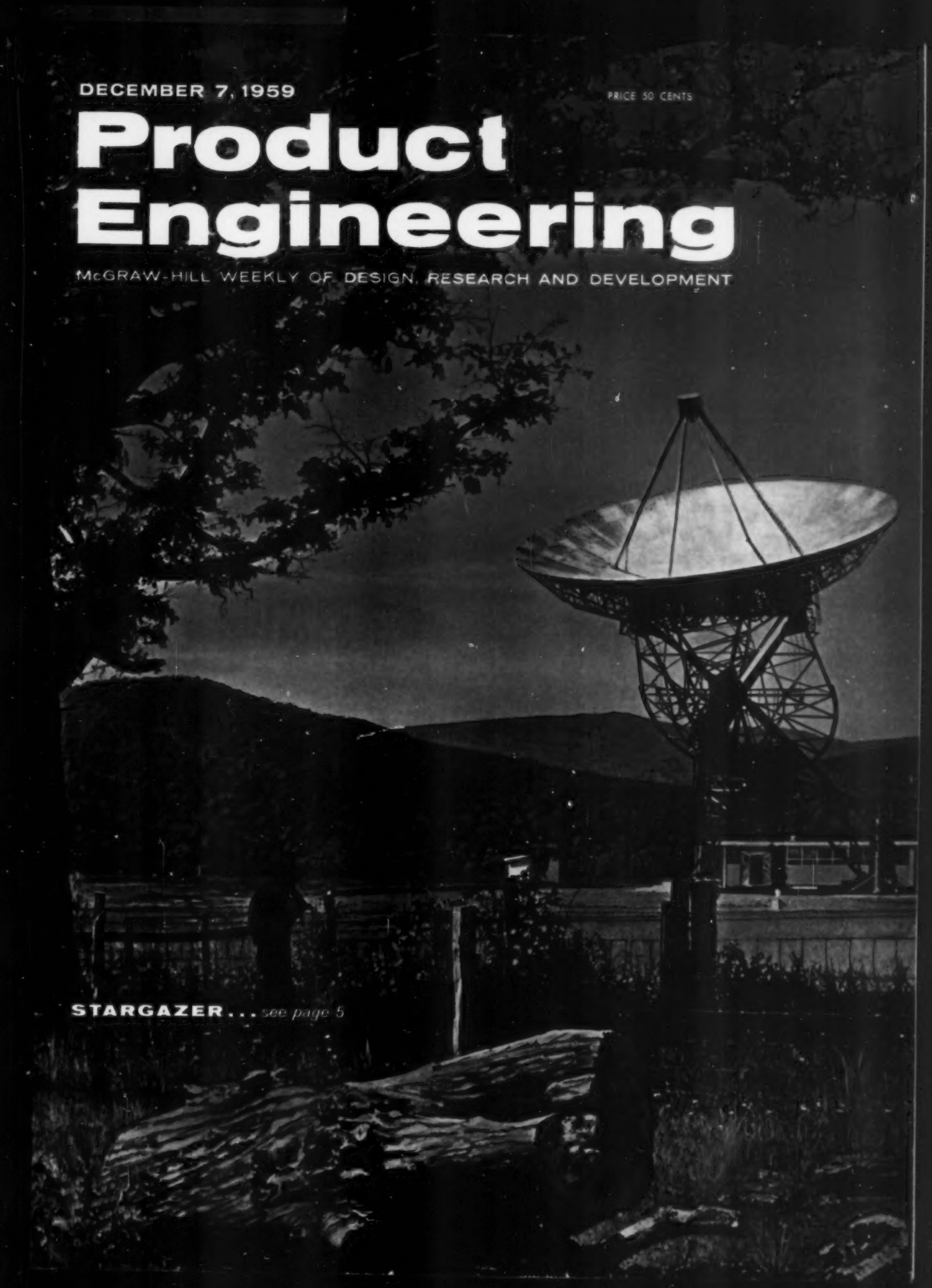
DECEMBER 7, 1959

PRICE 50 CENTS

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT



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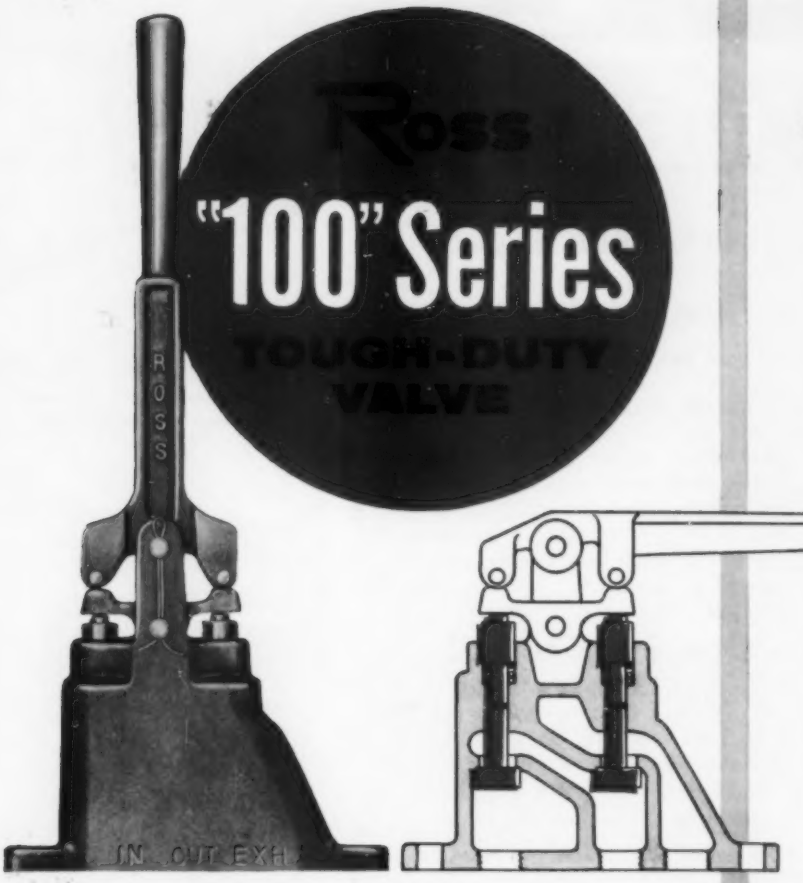
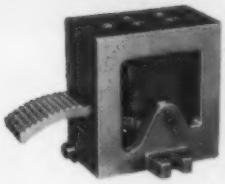


foot, cam, solenoid versions available, too



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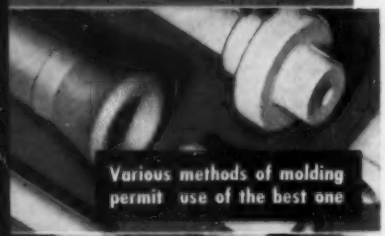

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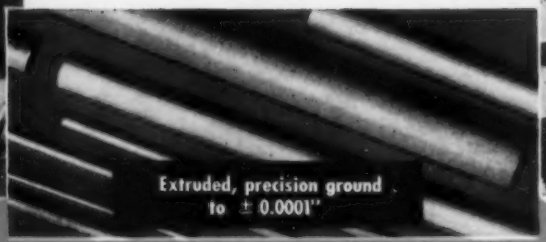

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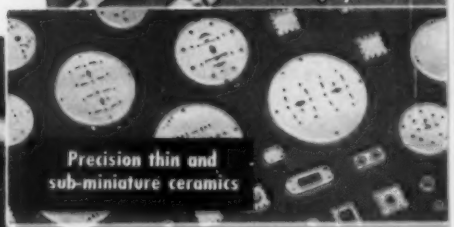

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Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

DESIGN issue

December 7, 1959 Vol. 30, No. 50

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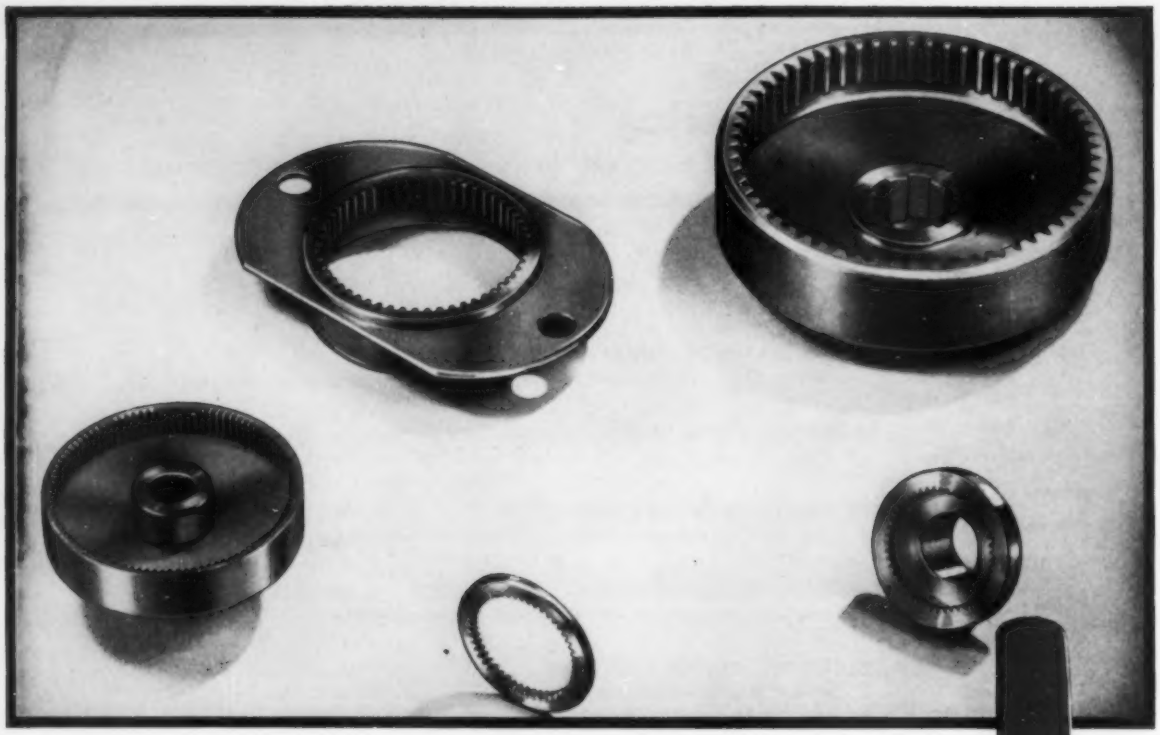

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Interesting to Note . . .

Looking Farther into Space

Our universe is one of the oldest mysteries of science. Because early man could not explain the visible phenomena of the heavens, myths quickly arose. Certain celestial bodies were observed and recorded some 5000 years ago—constellations, such as the Great Bear, have been found engraved on the walls of ancient caves. Records have also been found that show early man recognized a direct relationship between the heavens and farming. Shadow sticks indicated the time of year to plant and harvest crops. Also, seafaring nations learned there was a relationship between tides, weather and the heavens. However, the actual study of celestial bodies in a scientific fashion had to wait until the fourth century BC when Greek astronomers made the first progress toward understanding stars and planets.

Instruments for observing the heavens were crude and inaccurate. There was no such thing as a telescope in Ptolemy's day; it wasn't until the 17th century before a true optical telescope was developed. It's curious that it took 300 years from the first pair of spectacles to the first telescope. Jan Lippershey, a spectacle maker of Middlebury in Zeeland (Dutch) tried putting two lenses together. By so doing, he could bring the house across the street a little closer. It's hard to believe that Lippershey was the first to realize that two lenses are better than one, but in 1602 he petitioned his government for the exclusive right to manufacture an instrument for seeing at a distance. The State-General agreed, providing Lippershey's device could be used with both eyes. Therefore, the first telescope was a 1¾-ft tube with a binocular eyepiece. One of Lippershey's two lenses was simply the convex lens used in spectacles for the aged; the other, a concave glass suitable for a bad case of shortsightedness. Although this telescope was a crude instrument with a magnification of about 3 or 4 dia, it was the instrument that brought Galileo, Kepler and Huygens closer to outer space.

Thereafter, the development of telescopes moved rather quickly. Within 300 years of Lippershey's crude device, we built a 200-in. telescope at Mt Palomar that can bring to view stars over a billion light-years away. Because ordinary light waves are relatively short, scientists have now developed radio telescopes. These detect in the far-infrared region—where energy waves are longer than light waves. As long as a celestial object has a temperature above absolute

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Technical data for gasket design and selection

Why close tolerances in resilient gaskets are rarely necessary

Tolerances in the size and shape of a gasket do not become critical if the gasket material chosen seals effectively over a wide compression range.

Armstrong cork-and-rubber compounds are typical of such wide range materials.

Because they are truly compressible, they decrease in volume under load, so tolerances in size may be as wide as .010", even in completely

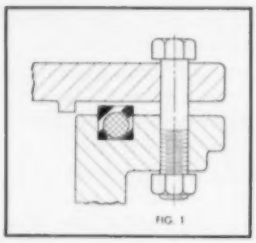


FIG. 1

confined space. In some applications, the wider tolerances allowed by compressible gaskets may effect savings in machining time.

The typical examples shown here illustrate how Armstrong cork-and-rubber materials help eliminate the need for close tolerances.

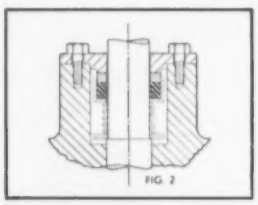


FIG. 2

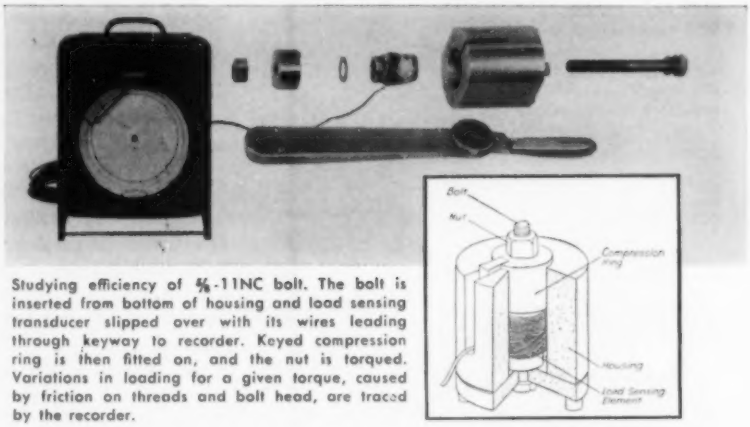
Figure 1 shows relative sizes of a resilient cork-and-rubber gasket and a non-compressible molded ring of comparable size. The cork-and-rubber compound permits wide tolerance in its size, whereas the molded ring must meet very close tolerances to allow perfect fit between the flanges.

Similarly, in figure 2, wide tolerance cork-and-rubber gaskets make an effective packing ring. Their true compressibility controls lateral flow and prevents excessive build-up of radial pressure on the shaft.

How varying bolt efficiencies affect flange loads, cause gasket leakage

Leaks often occur in gasketed joints where flange loads as calculated are thought to be adequate—or more than adequate—to create a seal. Such leaks are sometimes blamed on torque loss, when the real problem is inadequate initial flange pressure.

Data obtained with this device has led to a method of relating apparent flange pressures to actual flange pressures. This procedure compensates for



Studying efficiency of ⅝-11NC bolt. The bolt is inserted from bottom of housing and load sensing transducer slipped over with its wires leading through keyway to recorder. Keyed compression ring is then fitted on, and the nut is torqued. Variations in loading for a given torque, caused by friction on threads and bolt head, are traced by the recorder.

The major reason is that flange loads arrived at mathematically almost never equal the true load on the gasket. The explanation is friction . . . friction on threads and bolt heads that soaks up torque and reduces the pressure available to squeeze the gasket.

Although it is generally known that friction causes variations in bolt efficiency, little data has been available to indicate the extent of the problem. As a result, arbitrary compensations for friction are usually too low.

Armstrong research engineers have developed a device (shown above) which measures the effect on bolt efficiencies of varying screw thread conditions. Dry or rough threads, for example, give low bolt efficiencies which develop actual gasket loads much lower than torque readings would indicate. Lubricated threads give high bolt efficiency and result in gasket loads that approach the values calculated from bolt torque.

This data, combined with other new information on seal points of Armstrong resilient gasket materials, is useful in helping designers meet the minimum sealing conditions of a particular flange design and material.

Detailed information on this subject and other problems of gasket selection, design, and performance is contained in the new Armstrong Gasket Design Manual. Write for your personal copy.

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zero, it transmits such energy waves. With the radio telescope, a greater number of celestial bodies can be detected and a true picture of outer galaxies will be recorded.

Our cover shows the 85-ft-dia radio telescope that reveals outer space to the National Radio Astronomy Observatory, Green Bank, W Va. At present the telescope can reach 1 billion light-years, but refinements in receiving equipment will eventually increase its range to possibly 10 billion light-years. It was designed and fabricated by Blaw-Knox Co, Blawnox, Penna. The Navy is also building a radio telescope in nearby Sugar Grove, W Va. This 600-ft-dia instrument will "see" 3 billion light-years into space. When completed in 1962, the telescope will be the world's largest.

Films and Dresses

Taking snapshots with a block box-camera became faddish soon after the word "Kodak" joined our vocabulary. The amateur photographer was given a further boost in 1923 when Eastman Kodak Co announced the development of a safe motion picture film. This launched the home-movie fad. People throughout the country gathered in their living rooms, watching a film of baby's first steps. Cameras were crude, projectors cruder; but like many new developments there were bugs that still had to be worked out. Home movies now are commonplace. Cameras are rather inexpensive and easy to operate, projectors are smaller and easier to handle (see p 68).

When Kodak developed the safety film, it was found too expensive to be marketed commercially. Cellulose acetate, basis of the new film, had to find other applications in order to prove profitable. Scientists at the Tennessee Eastman Co worked on the problem, finally developing a synthetic fiber they called Estron. Not only did this fiber allow the cost of film to be cut, but it put Kodak in a new business. Now synthetic yarn is Kodak's third biggest product, just below film and photographic papers.

Wanted—Midget Repairmen

Miniaturization of home appliances may save the housewife a lot of valuable space, but has been raising havoc with servicemen. For years the task of crawling under the kitchen sink could assure the do-it-yourselfer a few bruised knuckles, possibly a bumped head. Now the lack of access space (p 62) under the sink is nothing as compared with the problem of servicing other appliances. My television repairman says there is one major TV manufacturer whose sets he wouldn't even attempt to fix. To replace an inexpensive resistor requires so much time and effort, for example, that the cost would shock the customer. "Take it back to the manufacturer," he says, "They built the monster, let their repairmen have the headaches."

Most American automobile manufacturers have done a good job in providing the access space needed to fix the family car. Gone are the days when an auto repairman had to dismantle the rear end when he wanted to repair the transmission. In order to grind the valves on one model of the famous old Bugatti, the rear axle, transmission and crankshaft first had to be removed. This became even more complicated when the repairman learned that the crankshaft came apart in 13 pieces.

But access space in aircraft design has been causing lost sleep to the aeronautical engineer. Aircraft companies have recently been using midgets to crawl into jet engines and check turbine blades. However, engineers who have to consider the maintenance and repair of their product can't always design with a midget in mind.

Judson and His Zipper

Connecting one object to another (p 71) is a familiar problem faced by design engineers. Yet, when Whitcomb L. Judson invented one of the most useful of all fasteners, the zipper, no one was interested. From the time he received his first patent on a slide fastener in 1893 until the time he received his fifth in 1905, not one person applied for a patent on a similar contrivance.

Fortunately, Judson had a friend, Col Lewis Walker, who backed him in forming the Universal Fastener Co to manufacture the zip fastener. Special machinery was designed and built. Then, when production problems mounted, Judson redesigned his fastener to enable the machines to make his product. So few people were interested in buying zippers that the company tried reorganizing and selling its fasteners door-to-door under the name "C-curity." Business got worse, especially when garment manufacturers turned a cold shoulder on the zipper idea, claiming that zippers had the annoying habit of popping open at the wrong time.

The company was close to bankruptcy when, in 1913, one of its young engineers, Gideon Sundback, further improved the zipper and the machines necessary for their manufacture. Clothing men were still uninterested. In 1918, the company was about ready to call it quits. Then a contractor making Navy flight suits bought 10,000 zippers—enough for the company to hold on a little longer. It was saved financially in 1923 when the B F Goodrich Co put zip fasteners on its galoshes. From then on, the zipper was here to stay.

—Benedict A Leerburger Jr

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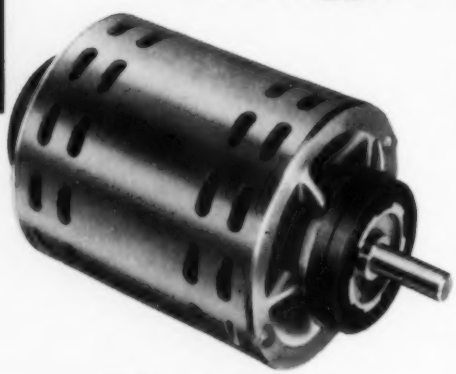

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Ideal for Fan, Pump, Gear Box and many other Applications... Now used by leading manufacturers for Frost-proof refrigeration

FIRST LOW COST UNIT WITH PRECISION BEARINGS • NEEDS NO OILING • TESTED FOR PERFORMANCE FROM −10° TO 250°F.

This exceptionally economical new unit bearing motor has a patented bearing construction that assures long, unattended life. It is fully guaranteed for 5 years—with a life expectancy of 10 years of continuous duty as shown by rigid lab tests. Available for a wide range of ambients, with skeleton frame or housed construction . . . tailored to suit your individual mounting requirements. Now being widely used to circulate air for frost-proofing refrigerator units. Lowest prices in the field—find out for yourself!

*Pat. No. 2,904,709

3

Motor Parts Sets cost less than ever with Howard's new, modern, semi-automated production facilities!

Cut costs on every product that uses individual motor parts with Howard's *complete*, quality-built and low priced line! Sets include armatures and fields, brushes and brushholders, rotors, stators and fans—in any combination as needed. If parts sets are your concern, let us show you our truly *competitive* line!

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MORE ABOUT THE GARLOCK **2,000**

(above) Fresh driver takes over underway during 50,000 mile test conducted by Kiekhaefer Corporation, makers of Mercury Outboard Motors. (*right*) KLOZURE Model 71 used on the Mercury has exclusive non-abrasive, free running sealing element resistant to oil, water, grease, heat and cold.

50,000 MILE OUTBOARD TEST

PROVES ENDURANCE OF GARLOCK KLOZURE* *OIL SEALS, TOO!*

In a fantastic non-stop endurance run equal to 20 years of average family outboarding, Garlock KLOZURE Oil Seals maintained positive sealing against grease and water without sign of physical wear or deterioration. Applied on the steering swivel shaft of two Mercury Mark 75E outboards, KLOZURES worked 'round the clock for 68 straight days keeping grease in the bearings. Hard knocks from rough water, floating obstacles, and foreign matter picked up at surface speeds averaging 30 miles per hour, could not injure the KLOZURES.

What better proof is there of long life and dependability! Garlock KLOZURE Oil Seals are compact, easy to install, and are available from one of the largest stocks of standard sizes for shafts from $\frac{1}{8}$" to 44". Whether it's in boating or industry, specify Garlock for the most effective seal on the market.

KLOZURES are another of the Garlock 2,000 . . . two thousand different types of packings, gaskets, and seals. The only complete line. It's one reason you get unbiased recommendations from your Garlock representative. Call him or write for KLOZURE Catalog 20.

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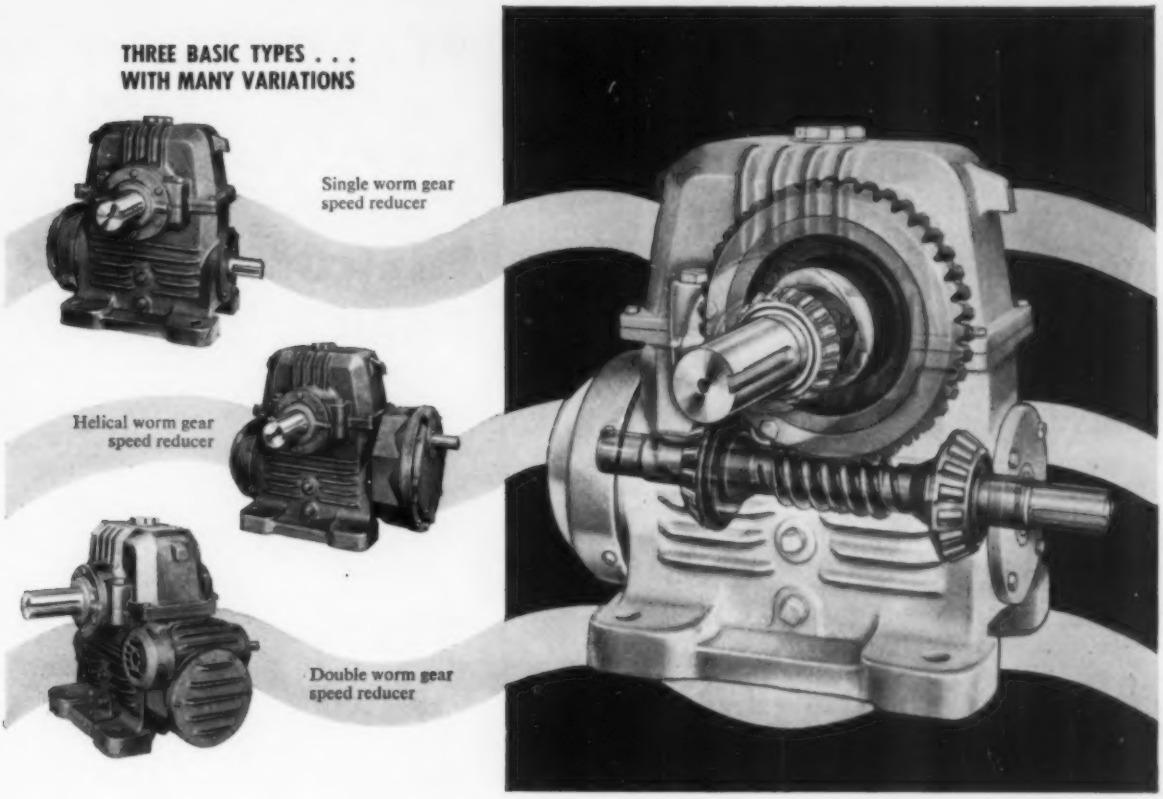
CIRCLE 10 ON READER SERVICE CARD

NEW LINK-BELT FAN-COOLED WORM GEAR SPEED REDUCERS

**THREE BASIC TYPES . . .
WITH MANY VARIATIONS**



most complete line in industry

Industry's most complete line of worm gear speed reducers introduces more advanced refinements for reducing high motor speeds to requirements of modern production machines. Types and sizes for every right-angle need . . . single or double reduction . . . horizontal or vertical mountings . . . ratios from 5:1 to 3600:1, torque ratings up to 135,000 pound inches, up to 150 horsepower.

Compact, self-lubricated and fan-cooled, these units operate smoothly and quietly under high input speeds. Power is transmitted at either moderate or slow output speeds, with ample capacity for heavy loads. This all adds up to high ratings, maximum heat dissipation and minimum maintenance.

For complete information call your nearby Link-Belt office. Ask for Book 2824.

LINK-BELT

SPEED REDUCERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,280

NEW! PLUG-IN ROLLER PLUNGER LIMIT SWITCH WITH *Exclusive* MICROMETER ADJUSTMENT

This new Square D roller-plunger plug-in limit switch is built for rugged machine tool applications—designed for cam-type operation and not restricted to direct, in-line approach of the actuator. Uses same field-proven precision switch mechanism as roller-arm type for long reliable operation. Moreover, it provides these important features:

Micrometer adjustment for fine adjustment of the roller after the switch has been mounted and wired. 1/8" movement of the roller plunger eliminates expensive cam shimming and adjustment.

Operating direction can be changed 90° for added flexibility. Roller plunger can be set either parallel or perpendicular to the base. No tools required.

Cam-type operation is possible because of the construction of the plunger assembly.

Oil-tight construction for all machine tool applications.

Plug-in construction · Switch plugs in—in seconds.

Easy wiring because all wiring can be done without removing from box.

Reversible plug-in unit can be positioned with roller plunger at either top or bottom.

Write for Bulletin 9007 AW. Address Square D Company, 4001 North Richards Street, Milwaukee 12, Wisconsin

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

CIRCLE 13 ON READER SERVICE CARD→

FLAME-PLATED WITH TUNGSTEN CARBIDE...

PIONEER'S THRUST CHAMBER TAKES BLASTING HEAT—LASTS 50% LONGER!

Aerojet General Corporation added 50% more operating life to Pioneer's second-stage thrust chamber with Linde's Flame-Plating process. Now, the lightweight aluminum tube, Flame-Plated with a thin (.003 in.) coat of tungsten carbide, has thermal and erosion resistance that stands up to the metal-killing temperatures of the combustion flame.

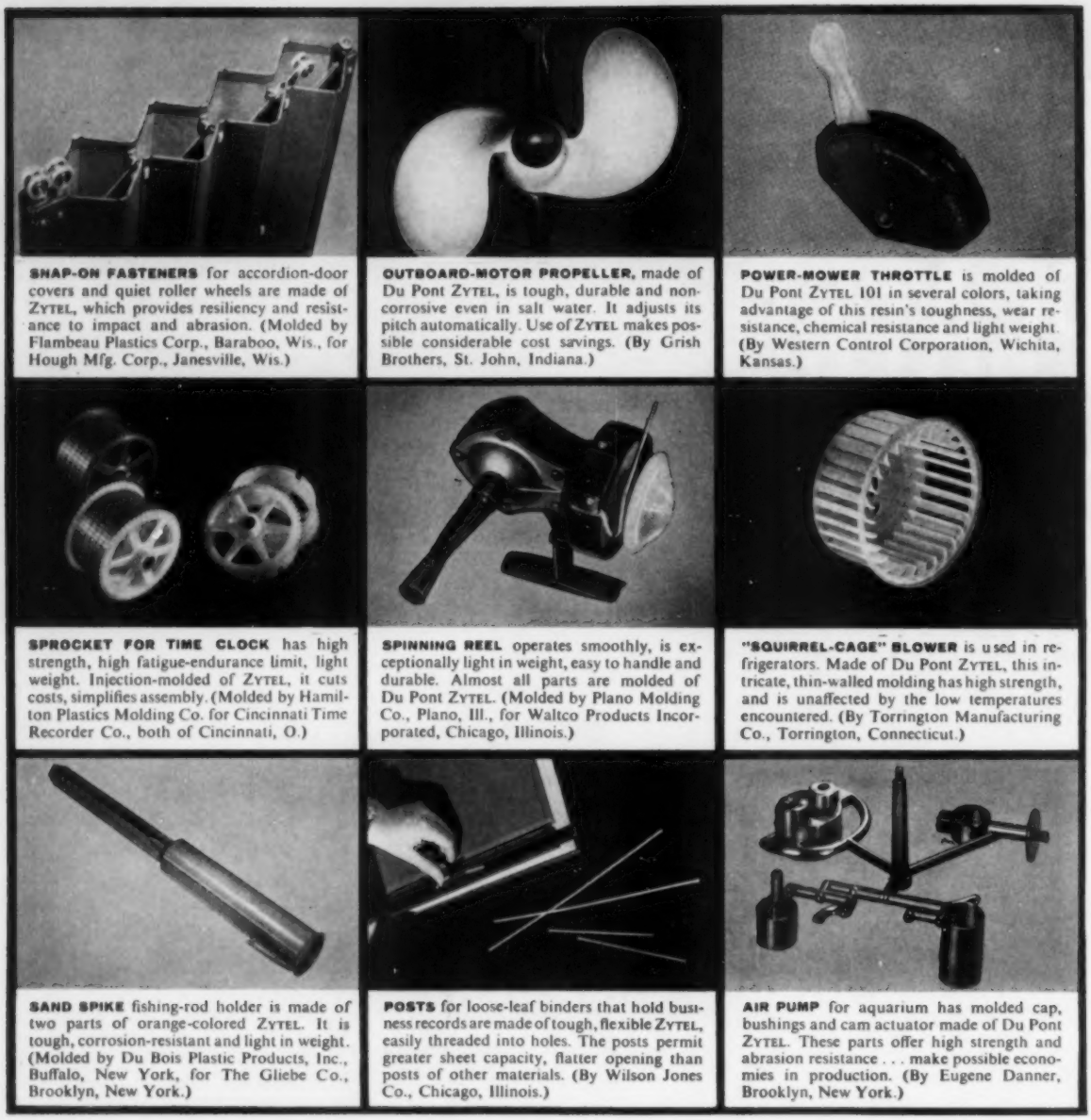
With this special Linde process, you can have metals coated with tungsten carbide, aluminum oxide, and other materials to provide outstanding resistance to wear, abrasion, and fretting corrosion, even at extreme temperatures. If necessary, these coatings can be ground and lapped to one micro-inch rms or better. They consistently outlast hard chrome plating, tool steels, and in some cases, solid tungsten carbide.

When coatings of refractory metals such as pure tungsten, tantalum, molybdenum, and other ultra-high-melting-point metals are desired, Linde Company offers its new "Plasmarc" Torch service. To find out how Flame-Plating or the "Plasmarc" Torch service can solve your critical temperature and wear problems, write Dept. PG-121 Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y.

Linde
TRADE MARK

UNION CARBIDE

"Linde", "Union Carbide" and "Plasmarc" are trade-marks and F-L-P is a service mark of Union Carbide Corporation.



SNAP-ON FASTENERS for accordion-door covers and quiet roller wheels are made of ZYTEL, which provides resiliency and resistance to impact and abrasion. (Molded by Flambeau Plastics Corp., Baraboo, Wis., for Hough Mfg. Corp., Janesville, Wis.)

OUTBOARD-MOTOR PROPELLER, made of Du Pont ZYTEL, is tough, durable and noncorrosive even in salt water. It adjusts its pitch automatically. Use of ZYTEL makes possible considerable cost savings. (By Grish Brothers, St. John, Indiana.)

POWER-MOWER THROTTLE is molded of Du Pont ZYTEL 101 in several colors, taking advantage of this resin's toughness, wear resistance, chemical resistance and light weight. (By Western Control Corporation, Wichita, Kansas.)

SPROCKET FOR TIME CLOCK has high strength, high fatigue-endurance limit, light weight. Injection-molded of ZYTEL, it cuts costs, simplifies assembly. (Molded by Hamilton Plastics Molding Co. for Cincinnati Time Recorder Co., both of Cincinnati, O.)

SPINNING REEL operates smoothly, is exceptionally light in weight, easy to handle and durable. Almost all parts are molded of Du Pont ZYTEL. (Molded by Plano Molding Co., Plano, Ill., for Waltco Products Incorporated, Chicago, Illinois.)

"SQUIRREL-CAGE" BLOWER is used in refrigerators. Made of Du Pont ZYTEL, this intricate, thin-walled molding has high strength, and is unaffected by the low temperatures encountered. (By Torrington Manufacturing Co., Torrington, Connecticut.)

SAND SPIKE fishing-rod holder is made of two parts of orange-colored ZYTEL. It is tough, corrosion-resistant and light in weight. (Molded by Du Bois Plastic Products, Inc., Buffalo, New York, for The Gliebe Co., Brooklyn, New York.)

POSTS for loose-leaf binders that hold business records are made of tough, flexible ZYTEL, easily threaded into holes. The posts permit greater sheet capacity, flatter opening than posts of other materials. (By Wilson Jones Co., Chicago, Illinois.)

AIR PUMP for aquarium has molded cap, bushings and cam actuator made of Du Pont ZYTEL. These parts offer high strength and abrasion resistance . . . make possible economies in production. (By Eugene Danner, Brooklyn, New York.)

Design advantages of ZYTEL® nylon resins demonstrated in wide variety of applications

Versatile ZYTEL nylon resins offer the designer a combination of properties that can be used to improve the performance and lower the cost of almost any mechanism. The high strength, abrasion resistance and low friction of ZYTEL make it an outstanding gear and bearing material. It is resistant to heat and chemicals. It can be economically injection-molded in intricate one-piece configurations, with moldings held to close tolerances. The result: reduction in inspection cost, material cost, fabrication cost.

Many molders have the experience to supply you with parts of ZYTEL nylon resin in quantity to your exact specifications. For your copy of a booklet, "Designing with ZYTEL nylon resins", write to: E. I. du Pont de Nemours & Co. (Inc.), **Department II-127, Room 2507Z, Nemours Building, Wilmington 98, Del.**

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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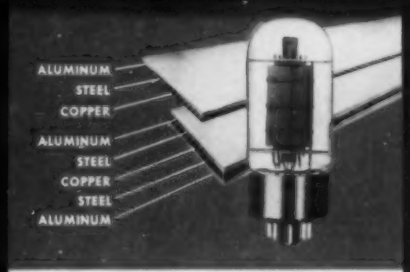
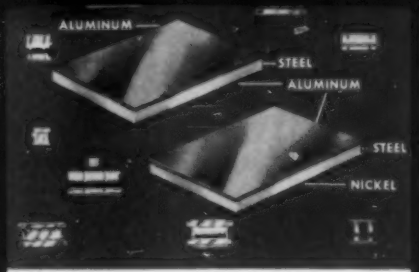
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

CIRCLE 15 ON READER SERVICE CARD→



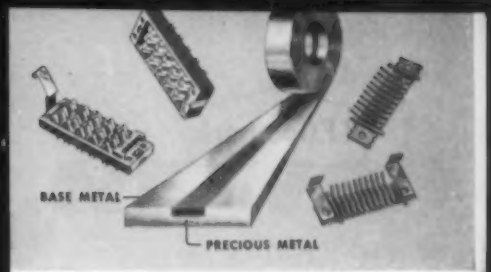
ALIRON® Copper-Base and Copper-Cored

Three-layer and five-layer materials used for anodes in rectifier and amplifier tubes. Provide longer power output life . . . uniform heat dissipation . . . high electrical conductivity . . . improved anode reradiation . . . and reduce costs.



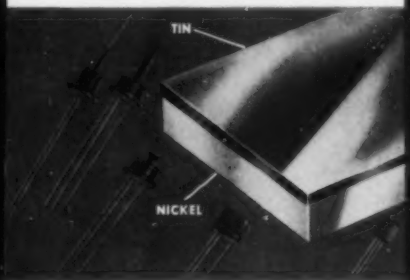
ALNIFER®, NIFER®

These clad metals are used as alternate materials for solid pure nickel in electron tubes. They conserve critical material . . . reduce costs substantially. Supplied in annealed coils ready for your production.



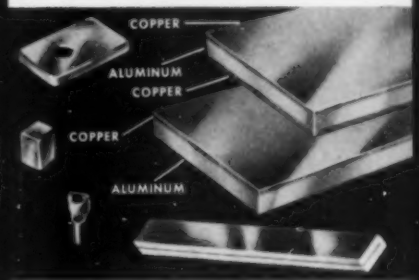
CLAD PRECIOUS METAL CONNECTOR MATERIALS

High reliability of connectors, clips, terminals obtained by using gold and other precious metal alloy stripe materials . . . place high performance materials in the contact areas . . . cost-savings and improved performance over gold electroplated parts.



TIN CLAD METAL STRIP and other Semiconductor Clad Metals

A number of combinations of clad metals are available for use on base tabs, lead wires, whisker wires, base materials and enclosures in silicon and germanium diodes, transistors and germanium power transistors.

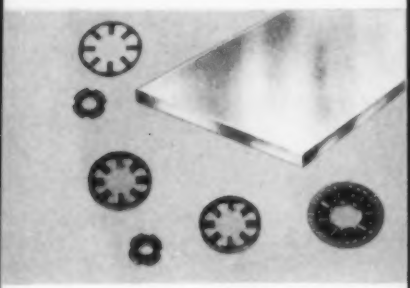


ALCUPLATE®

Easily formed, deep drawn or spun. Used for waveguides, component cases, variable condenser blades, chassis and electrical or thermal conductive parts. Light in weight, saves up to 30% over the cost of solid copper.

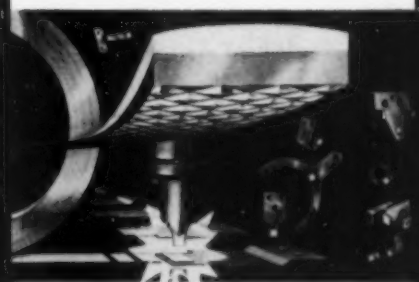
COPPER-CORED GLASS SEALING WIRES

Featuring a sound metallurgical bond, these wires give three times greater conductivity than solid 52 alloy wire of equal diameter . . . they facilitate miniaturization. Features include: leakproof seal between alloy and core, high electrical and thermal conductivity, lower costs.



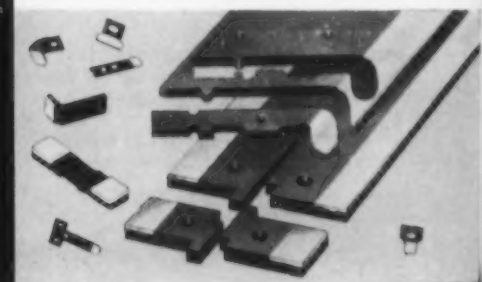
ALUMINUM-IRON ALLOYS

For magnetic applications requiring low core losses and high permeability at low flux densities in current and pulse transformers, relays, gyro mechanisms, servo mechanisms, missile guidance systems, etc.



CLAD ELECTRICAL CONTACT TAPES

For products you want to automate, this modern contact form permits greater latitude in contact assembly design . . . automatic assembly of two or more parts in a single operation. Tape contacts are easily attached by spot welding . . . are self-aligning . . . and allow broader assembly tolerances. Save up to 40% in contact costs.



CLAD CONTACT MATERIALS

Single and double inlay, overlay and toplay provide better electrical performance, longer operating life and lower fabrication costs. Complete assemblies can be made to close tolerances by single blanking and forming operations.

General Plate

Clad Metals and Clad

Electrical Contact Materials

Solve Design Problems...

Provide High

Performance Reliability

General Plate clad precious-to-base or base-to-base metals are inseparably bonded by a patented solid-phase bonding process without the use of brazing alloys or other intermediate material.

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy, investigate clad metals. If you want stronger or lighter components — or better electrical and mechanical properties — or fewer corrosion problems — or if you are interested in conserving critical metals or reducing parts costs, you can profit by using General Plate Clad Metals.

Write for a General Plate Clad Base Metals catalog today. Or better yet, why not talk over your requirements with a competent field engineer? His knowledge of the applications of clad metals is yours for the asking. No obligation, of course.

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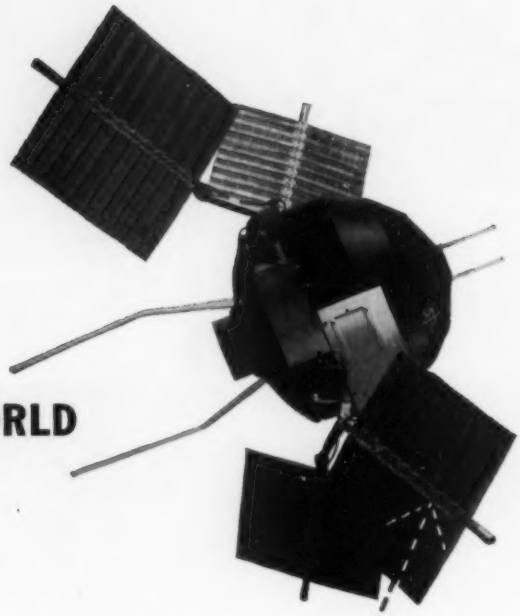
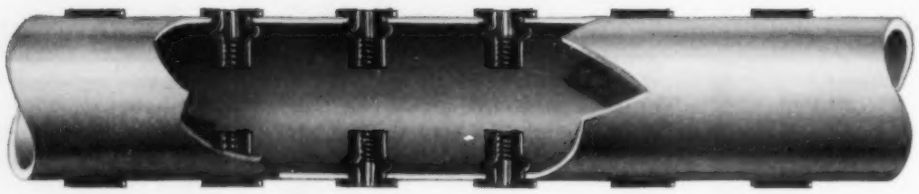


RIVNUTS® ARE OUT OF THIS WORLD



We've heard people say B. F. Goodrich Rivnuts are "out of this world." But now it's an established fact. They're in orbit on the Explorer VI "Paddlewheel" satellite, made by Space Technology Laboratories, Inc.

Upset inside the satellite's tubular spars (see cross section), Rivnuts provide solid nutplates for attaching the energy-producing solar cells. Rivnuts were chosen for use here because they are very light in weight and easy to install in blind tubular forms.

Rivnuts, the original blind fasteners with internal threads, come in a variety of types and sizes. You can now specify Rivnuts on your drawings by using N.A.S. numbers as shown on new N.A.S. drawings 1329 and 1330. Chances are there's a Rivnut that can help you simplify product design, speed assembly or cut costs in your manufacturing operation.

For a free copy of the Rivnut Data Book, write *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-129, Akron, Ohio.*

B.F.Goodrich *aviation products*

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 69

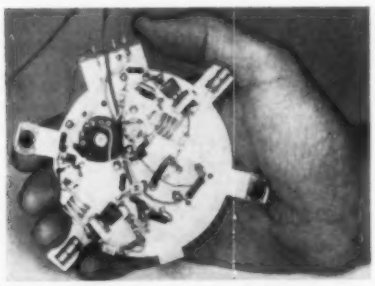
STOP ELECTRICAL LEAKAGE

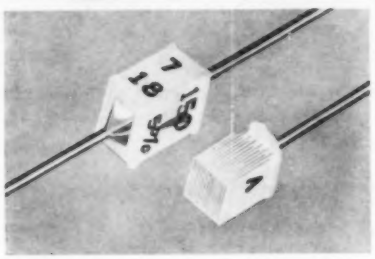
A thin coating of silicone fluid on electrical and electronic units is all it takes to prevent leakage paths. Here's how Vitramon Incorporated, Bridgeport, Connecticut, assures the reliability of its capacitors for missiles, aircraft and earth satellites.

"Vitramon" Capacitors must be able to withstand a wide variety of adverse environments both during storage and in operation. Consequently, the capacitors have porcelain bodies impervious to moisture. But condensation on the porcelain can form a conductive moisture film, permitting lead-to-lead short circuits.

Vitramon easily eliminates this by dipping the capacitors into a solution of Dow Corning silicone fluid. Easily applied, the silicone coating produces a thin, non-oily coating that causes condensation to bead, prevents formation of a conducting film and eliminates the possibility of shorts. In addition, the slick silicone coating protects the capacitors during handling and storage.

A typical application: "Vitramon" Capacitors play an important role in the tele-





metering transmitter (illustrated above) employed in the Vanguard missile. Other uses include guidance tracking and computing units on the Bullpup, Falcon, Explorer and other missiles, as well as on nonmilitary equipment. *No. 241*

LIGHTNING BARRIER

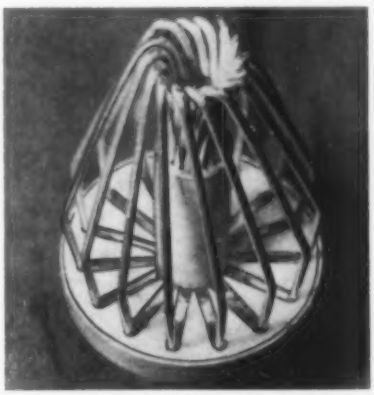
The structural and dielectric properties of silicone-glass laminates are the key to the solution of many intricate design problems. Here's a good example: the Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.

Aircraft are protected against lightning by metal skin and positive electrical bonding of movable surfaces. But long range HF communications systems of jet aircraft with probe-type antennas were subject to destruction by electrical discharge . . . until Joslyn engineers developed an effective lightning arrester.

Mounted near the antenna's base, the Joslyn arrester permits a normal flow of radio energy but diverts lightning current to the aircraft structure along a preferred path. A key component of the arrester is a slotted silicone-glass laminate spring guide. Punched from 0.0625 inch thick Phenolite G-7-832 made by National Vulcanized Fibre Company of Wilmington, Delaware, the slotted laminate serves as both retainer and insulator for 15 flexible phosphor bronze spring elements.

The Joslyn Aircraft Lightning Arrester is designed to operate at altitudes up to 50,000 feet and will withstand temperatures ranging from —80 F to over 160 F. Its construction is designed to safely discharge lightning strokes having peak current as high as 100,000 amperes and 200 coulombs charge.

Phenolite G-7-832 made with Dow Corning Silicones was selected because it provides



the high physical and high dielectric strength required; withstands severe vibrations without fatigue or breakdown; is resistant to fungus growth; and allows the spring elements to move in and out on a guided, insulated path with no danger of touching any other metal surface. Easy fabrication of the silicone- *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE
OR REFERENCE NUMBER ON READER SERVICE CARD

MORE

PROTECTS AND SEALS FLOODS

Designing quality outdoor lighting — floods, spots, clusters — is an exacting science at Stonco Electric Products Company, Kenilworth, New Jersey. And Stonco engineers report that Silastic®, the Dow Corning silicone rubber, provides a long-lasting water-tight seal . . . assures reliability in every kind of weather, even with the lamp face up.

Currently producing outdoor lighting engineered to meet every commercial and industrial need . . . from ball park lighting to portable floodlights for emergency squads . . . Stonco Electric is adding a complete new line of decorative outdoor "bullet" spots for home use.

Stonco designers specify that the gaskets for all their top quality outdoor lampholders be made of Silastic. They report that in addition to providing a weatherproof seal, the durably resilient silicone rubber gaskets lock the lamps securely in their sockets, and cushion them against pole whip and vibration . . . help provide longer lamp life.

This is another instance where the unusual properties of Silastic helped engineers design a better product. Serviceable from —130 to 500 F and resistant to weathering, oxidation and electrical breakdown, Silastic parts and components play important roles in many aircraft, automotive, electrical and electronic applications. For more information on the properties of Silastic and the advantages this silicone rubber can offer you in the products you design, circle ..... *No. 242*

GLASS LAMINATES *(Continued)* glass laminate provides another "plus." Despite their intricate shape, the spring guides are punched out with little difficulty.

This combination of properties is the reason silicone-glass laminates are so practical — so widely used both as electrical components and as structural members in aircraft and in electrical and electronic equipment. *No. 243*

PROPERTIES OF SILICONE-GLASS LAMINATES
(NEMA Standards for Sheets)

Flexural strength, flatwise, 1/8 inch thickness	20,000 psi min.
Izod impact strength, edgewise	6.5 min.
Dissipation factor at 1 megacycles, 1/8 inch thickness, condition A ..	0.003 max.
Arc resistance, seconds,	
Condition A	180 min.
Condition D 48/50	180 min.

new literature and technical data on silicones

Summary of Silastic Stocks and Pastes is a convenient index to properties, uses, and processing techniques of the 17 Silastic stocks and pastes usually selected to meet a range of performance requirements. This four-page compactly organized listing is prepared to help designers select at a glance the most useful silicone rubber for any application. *No. 244*

Solution Found—A reprint from Missile Design & Development describes how high voltage power supply units are potted with Dow Corning Dielectric Gel . . . and how the use of this unique, transparent resilient silicone product in missile-borne electronic equipment provides noteworthy advantages not attainable with other potting materials. A valuable aid in designing toward miniaturization and greater reliability. *No. 245*

Where, When and How you can use Silastic RTV advantageously is detailed in a new folder bulletin. Complete information on the various Dow Corning silicone rubbers that vulcanize at room temperature is presented in several fact filled data sheets written to aid in all applications. Whether you need prototypes, or want to caulk, seal or gasket a unit, or have to mold intricate parts, you'll want a copy of this reference folder. *No. 246*

Greater Stability Plus. Silicone diffusion pump fluids make the operation of pumps more efficient over longer periods of time and under more adverse conditions. After as many as 1100 cycles of heating to operating temperature and partial cooling, with exposure to air during each cycle, silicone fluids do not decompose into gums or tars. Rapid recovery, quick pump-down, inertness, fine vacua and economy are other advantages of using Dow Corning diffusion pump fluid. *No. 247*

Dow Corning Corporation, Dept. 8624, Midland, Michigan

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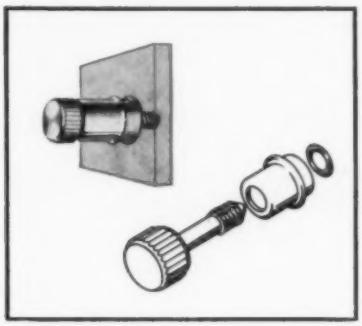
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE IN COUPON ABOVE, OR REFERENCE NUMBER ON READER SERVICE CARD

Compact Captive Panel Screws:

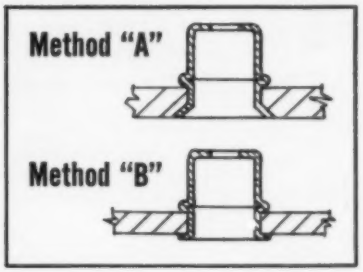
Standard Design Lowers Installed Costs

No longer is it necessary to resort to a costly fastening device of special design to provide quick attachment and release of electronic components. Standard Southco Retractable Screw Fasteners (stand-off thumb screws), available from stock, are both fast to install and economical. The five sizes,

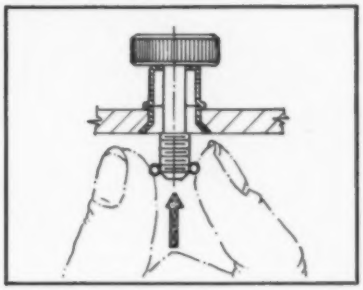


shown below, meet a very wide variety of requirements.

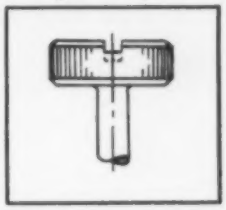
Check these advantages of simplified Southco Captive Panel Screws. Even when many screws are in one panel, misalignment is easily handled because the screw floats in a large hole in the stand-off, allowing ample play for "lining up." No special tools are



needed for installation, thus production is not subject to tool failure, nor limited by either the number of special tools available or the number of personnel trained in their use.

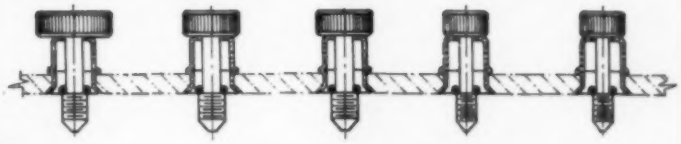


The Southco No. 58 Retractable Screw Fastener consists of three parts: thumb screw, stand-off, and retaining ring. The bright nickel-plated brass stand-off is inserted in either a drilled and countersunk hole (Method A), or a drilled hole (Method B), and flared. The polished, chrome-finished brass screw is passed through the hole in the stand-off and made captive by a retaining ring. Engaging in a tapped hole in the frame, the screw may be fully withdrawn without moving the panel, yet always is retained.



The unslotted screw is standard in 3/4", 9/16", and 7/16" head diameters and three thread sizes. Slotted head screws are also available in all sizes. The stand-off is standard in sizes to fit panel thicknesses from a minimum of 1/16" to a maximum of 17/64". Screw and stand-off are also obtainable in stainless steel.

MINIATURE TO LARGE SIZE HEADS IN FIVE TYPES



HEAD DIAMETER	3/4"	9/16"	9/16"	7/16"	7/16"
THREAD SIZE	1/4-20	1/4-20	12-24	10-24	10-32

Free Fastener Handbook

Send for your complete Southco Fastener Handbook, just printed. Write to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

BLIND RIVETS | ¼ TURN FASTENERS | ADJ. PAWL FASTENERS | DOOR LATCHES | RETAINING SPRINGS | ANCHOR NUTS

©1959

SOUTHCO FASTENERS

LION

You're in for a Hot Time

but Fenwal's New Miniature

Hermetically Sealed THERMOSWITCH® Unit will control it—precisely!

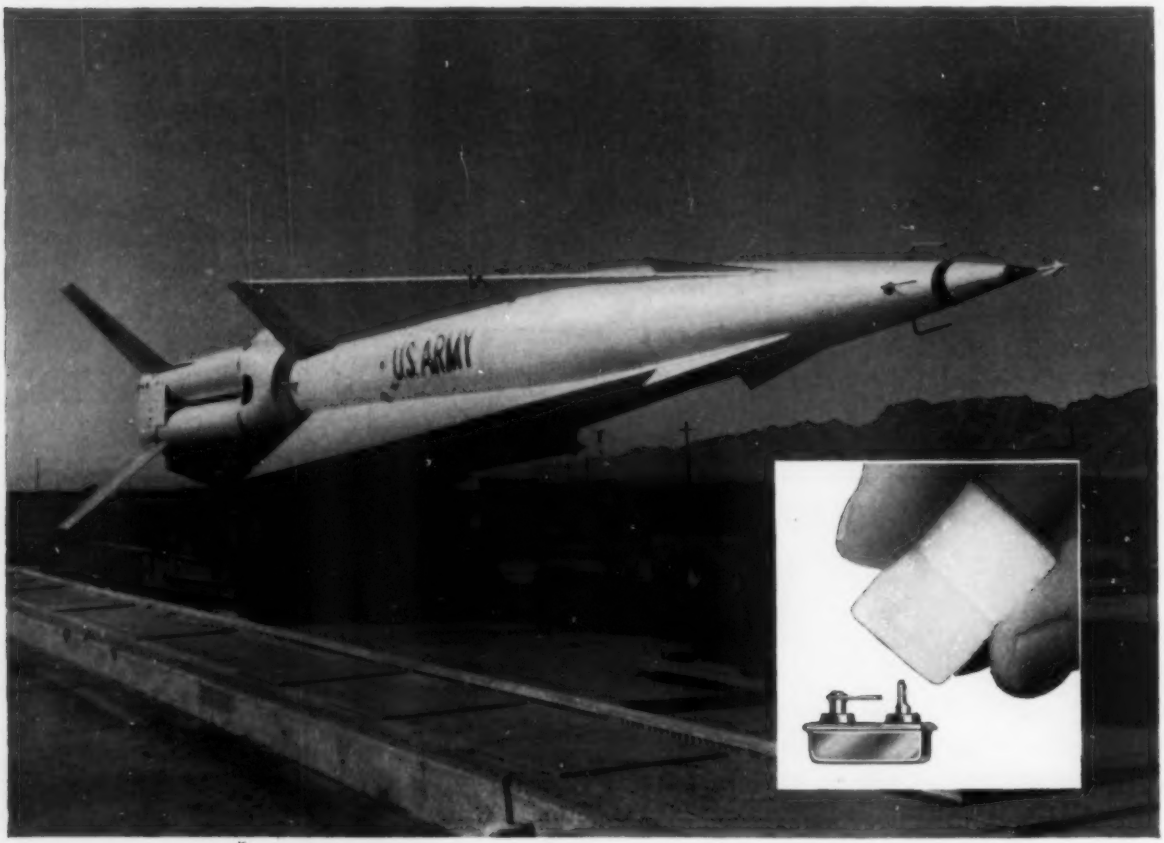
There'll be a hot time in the old ionosphere tonight. But with Fenwal's new Miniature Hermetically Sealed THERMOSWITCH Unit aboard everything will be under control. This tiny Fenwal unit responds quickly and accurately to temperature changes — *it's reliable!*

It's hermetically sealed, yet field adjustable. Even extreme vibration and shock won't upset its control characteristics — *it's built to take it!*

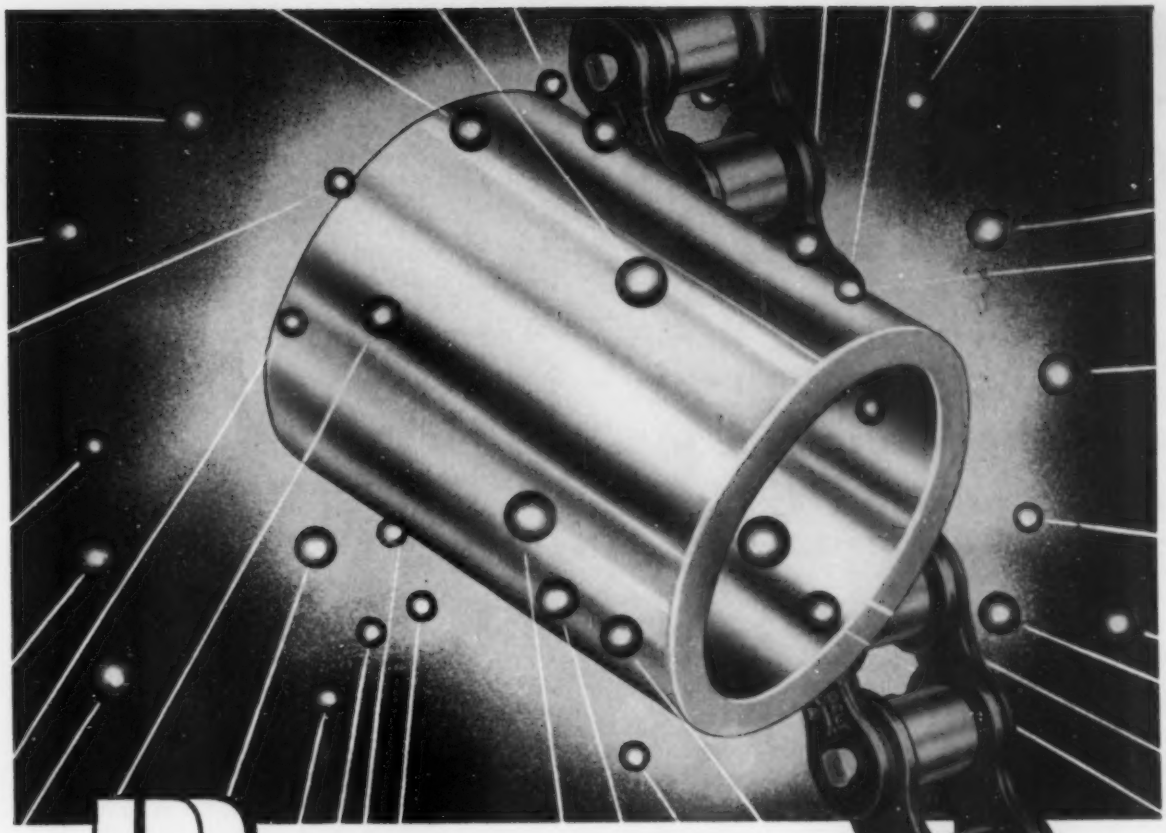
But most of all, this corrosion-resistant Fenwal unit does it all with exacting control of within 1° — in temperatures of −20°F to +200°F (−65°F to +220°F exposure limits). And it's the only unit that has all three features — *small size, ruggedness and precision control!*

If missiles are your business you'll want all the information on this tiny, tough, sensitive and reliable control. For more information on this unit or complete Fenwal temperature control systems, write for our catalog. If you want, we'll send our sales engineer, too. Fenwal Incorporated, 212 Pleasant Street, Ashland, Massachusetts.

The new Fenwal Miniature THERMOSWITCH Unit (compared here with a lump of sugar) weighs less than ½ oz. Its current capacity is 2.5 amps, 115 VAC, 2.0 amps, 28 VDC. Widely used for crystal ovens, tuning forks, gyro assemblies, missile blankets and missile batteries.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY



Rollers

fortified against fatigue

Shot-peening "cold-works" extra fatigue life into LINK-BELT roller chain

Shot-peening gives rollers of Link-Belt precision steel roller chain exceptional strength and stamina. And after shot-peening, they are burnished rather than ground or sanded. This achieves a SILVER-BRITE finish—and more important, *retains the fatigue resistant qualities of shot-peening.*

Other long-life "extras" of Link-Belt roller chain include: close heat-treat control, lock-type bushings, pre-stressing, pitch-hole preparation. For details, see Book 2657.

LONG LIFE AHEAD! Rollers for Link-Belt precision steel roller chain tumble out of shot-peening machine after being cold-worked to withstand punishment of today's high-speeds and heavy loads.

LINK-BELT

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,082

BOOK 2657 has 154 pages of roller chain data. For your copy, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.)

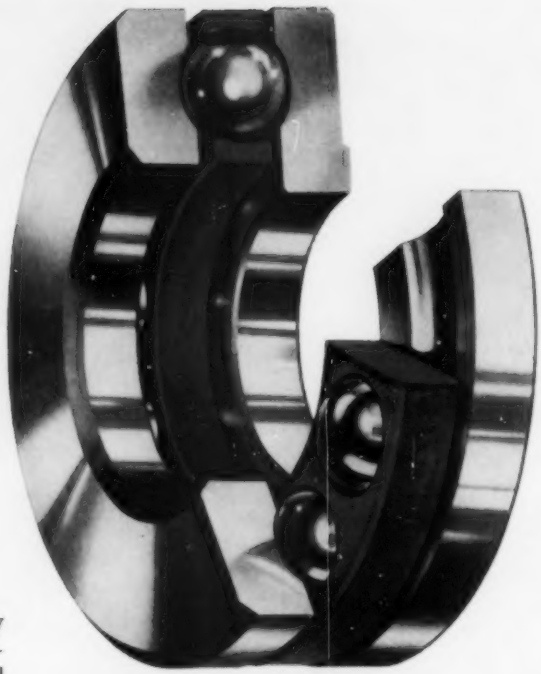
Aetna Bearing

PRECISION

begins with Rigid Steel Specification—

Laboratory Analysis—

and Controlled Heat Treatment



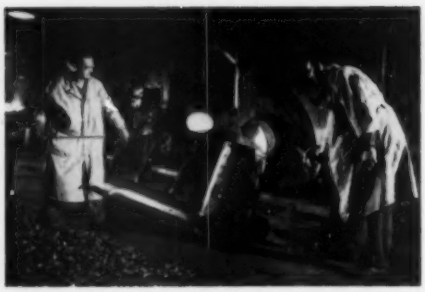
Each shipment of every grade of steel is chemically analyzed and tested for conformity to specifications—then laboratory tested for hardenability, cleanliness and grain structure before acceptance.

Heat Treatment then gives the exact degree of hardness for full bearing load capacity and long service life . . but hardness must be controlled—over hardening imparts brittleness to steel; under hardening reduces life and load capacity. Every piece of Aetna hardening equipment is therefore controlled automatically by recording type electrical instrumentation which provides absolute accuracy in both temperature and time of the heat treating cycle.

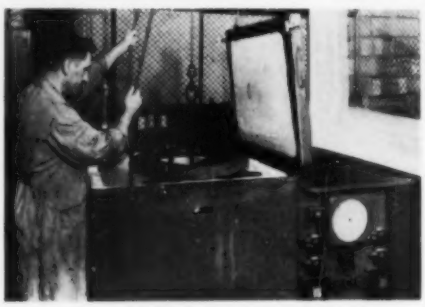
Sub-zero Cold Treatment is used for bearing steels requiring extremely close tolerance to permanently stabilize the structure, and effect the ultimate in fatigue resistance and reliability.

The result of these exacting treatments is available in Aetna Bearings which are capable of taking and maintaining the exceedingly fine finishes which secure true anti-friction performance. *You have a better operating product when it is equipped with Aetna Bearings.*

Precision Parts held to the same exacting standards, produced in quantity at low cost to your exact specifications. Size to 38" O.D. Submit blueprints, quantities and delivery for quotation.



Unloading a heat from one of a battery of carburizing furnaces.



Heavy duty ball race receiving minus 150° F. cold treatment to completely transform steel structure to tougher, more stable martensite.

AETNA BALL AND ROLLER BEARING COMPANY

Aetna

DIVISION OF PARKERSBURG-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

"To keep Whirlpool first line requires first line steels" —LESTER FIRST—DIRECTOR OF QUALITY CONTROL

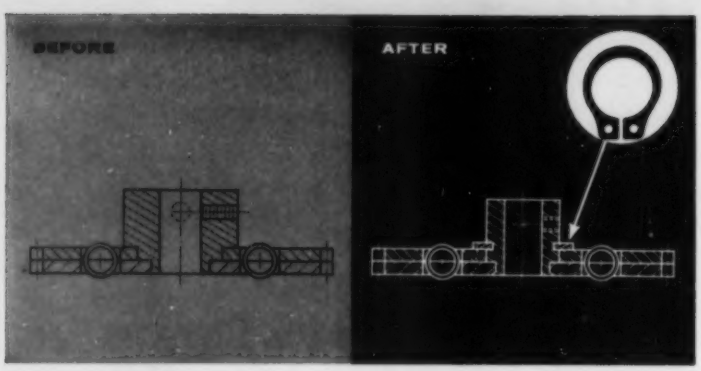
"Quality control is important to Whirlpool, and to maintain the highest standards we must begin with quality materials," says Lester First, Director of Quality Control at Whirlpool's Clyde, Ohio plant.

"Through constant checking I find that Sharon is one of our suppliers we can rely on for consistently good steel right to our specs," Mr. First continues.

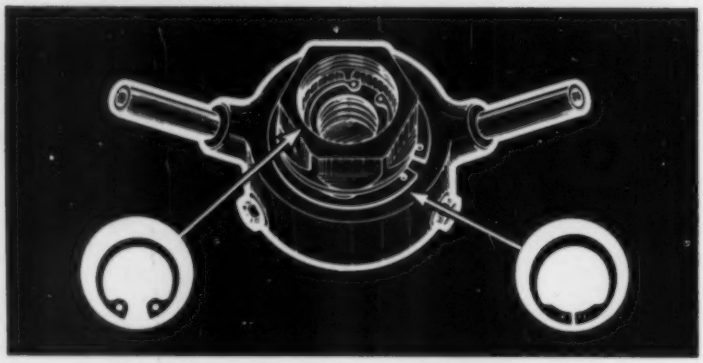
Leading appliance makers, like Whirlpool, know there's no substitute for quality steel. For quality steel there's nothing finer than that produced in the mills of the *Sharon Steel Corporation, Sharon, Pa.*

SHARONSTEEL **SHARON** *Quality* **STEEL**

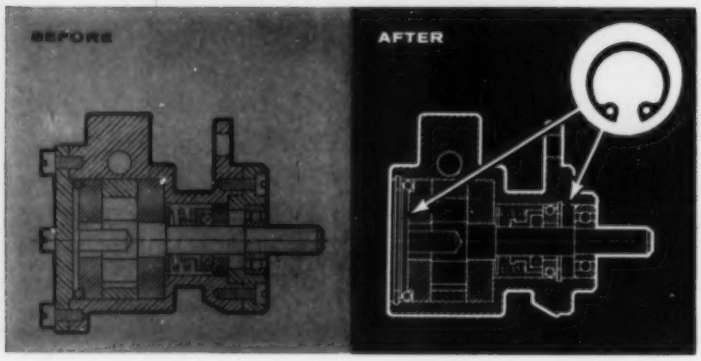
CIRCLE 23 ON READER SERVICE CARD



Gear assembly improved. A Waldes Truarc Series 5100 retaining ring in this anti-backlash gear assembly eliminates machining and staking operations, reduces hub size, and allows easy disassembly, after gears are cut as a unit, for faster, better deburring. **Typical savings: $350.00 per 1000 units.**



Threaded retainers eliminated. In this self-sealing coupling, costly internal and external threaded retainers were eliminated by easy-to-apply internal (Series 5000) and external (Series 5108) Truarc retaining rings. **Savings per unit amounted to $4.02.**



End-cover design simplified. In this general-purpose pump, two Waldes Truarc, Series 5000, internal retaining rings make possible the elimination of two cover-plate castings (plus machining) and eight screws (plus drilling and tapping). Weight and dimensions are reduced and assembly and disassembly are greatly facilitated. **Typical cost savings: $1.48 per unit.**

©1959 WALDES KOHINOOR, INC.

Designing for axial assembly with Truarc retaining rings

eliminates parts, machining, speeds assembly, simplifies maintenance

The proper application of retaining rings on or in axial assemblies can often effect startling simplifications and economies in design when compared to corresponding designs with conventional fastening devices. A few typical examples, using basic types of retaining rings, are shown in the accompanying drawings.

Threading, tapping, drilling, facing and other costly, time-consuming operations can be eliminated. Retaining rings are already in wide use in a tremendous variety of equipment ranging from household products to high-precision military gear designed for use under the most severe environmental conditions. They are quickly and simply installed in easily cut grooves which can often be machined simultaneously with other operations. The rings can frequently replace bulkier, more costly fastening devices —such as nuts, screws, studs, threaded sleeves and retainers, cotter pins, set collars, rivets and machined shoulders.

What's more, rings frequently make practical designs which could be achieved with no other known fastening device.

Although the ring types shown here are basic, Truarc retaining rings come in 50 functionally different types, as many as 97 different sizes within a type, 6 metal specifications and 13 finishes. You'll find detailed descriptions of Truarc retaining rings and assembly tools, plus more than 70 typical applications in the new 24-page catalogue RR10-58. Write for your copy today.

And remember, Waldes engineers are always ready to help you solve your application problems—whether it involves one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

J. F. HARPER, OF HARPER
BUFFING MACHINE COMPANY, SAYS . . .

"General Electric Motor *Econo-matching** Saved Me Over $1300 Per Machine!"

***GENERAL ELECTRIC ECONO-MATCHING** is the quick and accurate matching of Tri-Clad '55' a-c motors to machines by skilled G-E engineers.

ECONO-MATCHING recently helped increase equipment efficiency and reduce unit costs at Harper Buffing Machine Company, East Hampton, Connecticut.

After selecting a drive to power his new "Harperizer†" free-grain buffing machine, J. F. Harper (above center) called his G-E Distributor, who in turn arranged for a team of General Electric Econo-matching engineers to study its drive requirements —at no cost to Mr. Harper!

"G-E ENGINEERS STUDIED OUR APPLICATION," said Mr. Harper, "and advised that we could get maximum efficiency and economy by replacing the drive we had selected with a Tri-Clad '55' 50-hp open drip-proof motor. We did, and realized an immediate savings of over $1300 per unit!".

MORE THAN THREE BILLION integral-hp a-c motor types are available to the G-E engineers who can select the drive to meet your needs. Let them help you get the most from your equipment investment!

†*Trademark of Harper Buffing Machine Co.*

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RETURN THIS COUPON . . .

for more Econo-matching details, or call your nearby General Electric Apparatus Sales Office for complete information on how G.E. can ECONO-MATCH a motor to meet your specific requirements.

Section G891-22A
General Electric Company
Schenectady, New York

Please furnish more information on how you can ECONO-MATCH a motor for my application, which is _____

NAME _____ TITLE _____

COMPANY _____

CITY, STATE _____

In *Ford* Farm and Industrial Tractors...

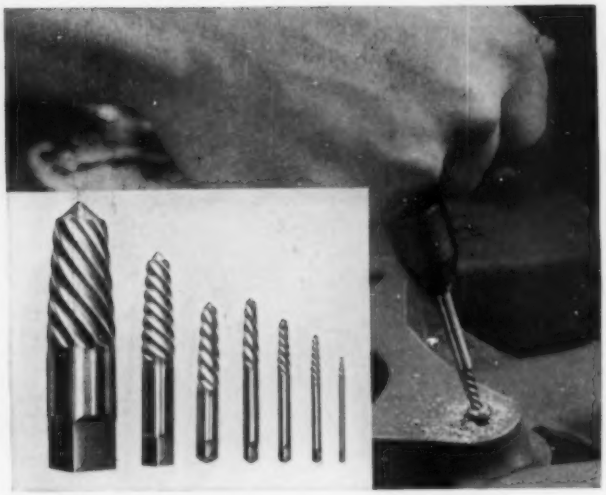
REPUBLIC DIE-FORM CUTS PTO COUNTER-SHAFT COST

FORD TRACTOR POWER TAKE-OFF COUNTER-SHAFT costs less to produce using a Republic Die-Form blank, as compared with previous materials. Blank is shown immediately below . . . completed shaft at bottom. Use of Die-Form blanks may enable you to produce a superior part for less money. Clip and send coupon for facts.

By using Republic Die-Form blanks to produce power take-off counter-shafts, Ford engineers gain substantial production economies. Because they closely approximate the completed part, Die-Form blanks minimize required machining and reduce handling costs for raw material and scrap disposal. In addition, the nature of the Die-Form Process actually improves machinability of any given steel analysis, permitting further savings through use of higher speeds and feeds.

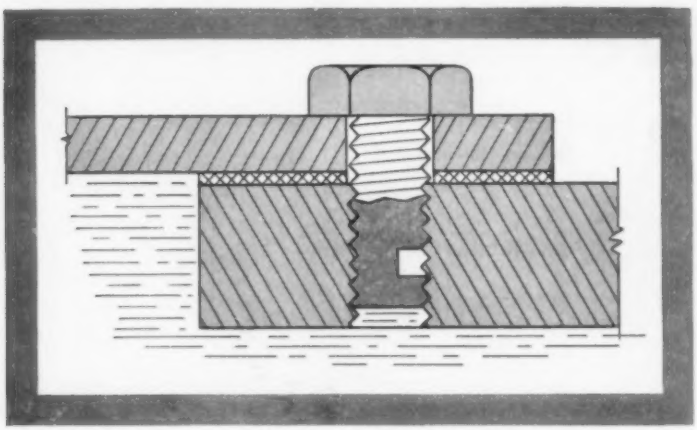
The Republic Die-Form Process is a cold work operation performed by forcing one or more sets of dies over each end of a hot rolled steel bar. Resulting multi-diameter bar, in addition to the cost-saving advantages outlined above, offers improved yield and ultimate strength. Diameters are accurate to within .005 inches which may, in some cases, entirely eliminate further finishing.

If you mass produce multi-diameter machine shafts it will pay you to investigate the savings potential of Republic Die-Form. Your nearest Republic office can provide details. Or write for Die-Form Folder ADV-746.



QUALITY AND ECONOMY ARE ASSURED in screw extractors made of Republic Cold Drawn Leaded Alloy Steel by the Henry L. Hanson Company, Worcester, Massachusetts. Beneficial characteristics of this versatile material include high machinability, formability, hardenability, and toughness. As a result, screw extractors can be produced faster and at less cost than was possible with former materials and, after scientific heat treatment, are practically unbreakable. Republic Cold Finished Alloy Steels are available in every standard analysis, plus many specials. Mail coupon for further information.

UNIQUE TITANIUM SPEED BRAKE... brings Republic Aviation's F-105 fighter-bomber from *Mach 2* to subsonic speeds quickly and with no appreciable loss of stability. Working closely with design engineers, Republic Steel supplied titanium products for the 360-degree speed brake. Hot formed, the titanium "petals" withstand searing 700-degree temperatures and the 90,000 psi impact accompanying brake extension at *Mach 2*.



LIQUID SEALING PERFORMANCE is an added benefit of Republic Self-Locking Nylok® Bolts. As shown here, the nylon pellet in compression tends to expand and interrupt space between non-loadbearing surfaces of mating threads when bolt is wrenched tight. Fluid escape along helical thread path is blocked. Nylon pellet resists aging, moisture, and ordinary solvents to provide a long-lasting seal. Send coupon for information on all the benefits of Republic Nylok Fasteners.

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☐ Nylok Fasteners
☐ Cold Drawn Alloy Steel

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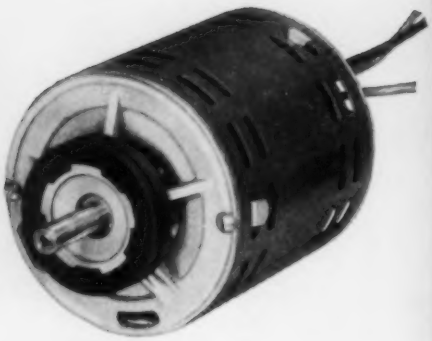

this R & M motor puts the "Drive" in IBM electric typewriters!

Almost twelve years have elapsed since International Business Machines Corporation used its first R&M motor to power its electric typewriters. Since then R&M has supplied thousands upon thousands of these special motors for IBM's world-wide typewriter trade. In order to meet varying electrical conditions the world over, they are now supplied in 21 different voltages and frequencies.

IBM proposed strict requirements for powering their machine. The motor must have high starting torque for quick response . . . run very quietly . . . cooler than normal . . . fit a limited space . . . and have stamina to perform dependably year after year. Within a short period of time, R&M delivered specifications for the right design—a dynamically balanced motor that fulfilled all of IBM's standards, including reliable operation that covers thousands of hours between check-ups.

A lot of fingers have gone over the keys since R&M produced its first IBM typewriter motor, but we still subject each IBM power unit to 100% inspection. Moreover, we constantly work with IBM—and all our customers—to improve our motors and to adapt them to the ever-changing requirements of customers' products.

R&M's experience in custom-designing motors for hundreds of products, and our facilities to produce a design at low cost, are at your service. Perhaps your problem can be met with a standard *"off-the-shelf"* power unit. If so, we'll tell you . . . and recommend the right R&M motor for the job. For power by either custom or standard fractional HP motors . . . and performance that will give you a big competitive advantage . . . get in touch with Robbins & Myers today! Write for Bulletin No. 450-PRE

ROBBINS & MYERS, INC.

motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

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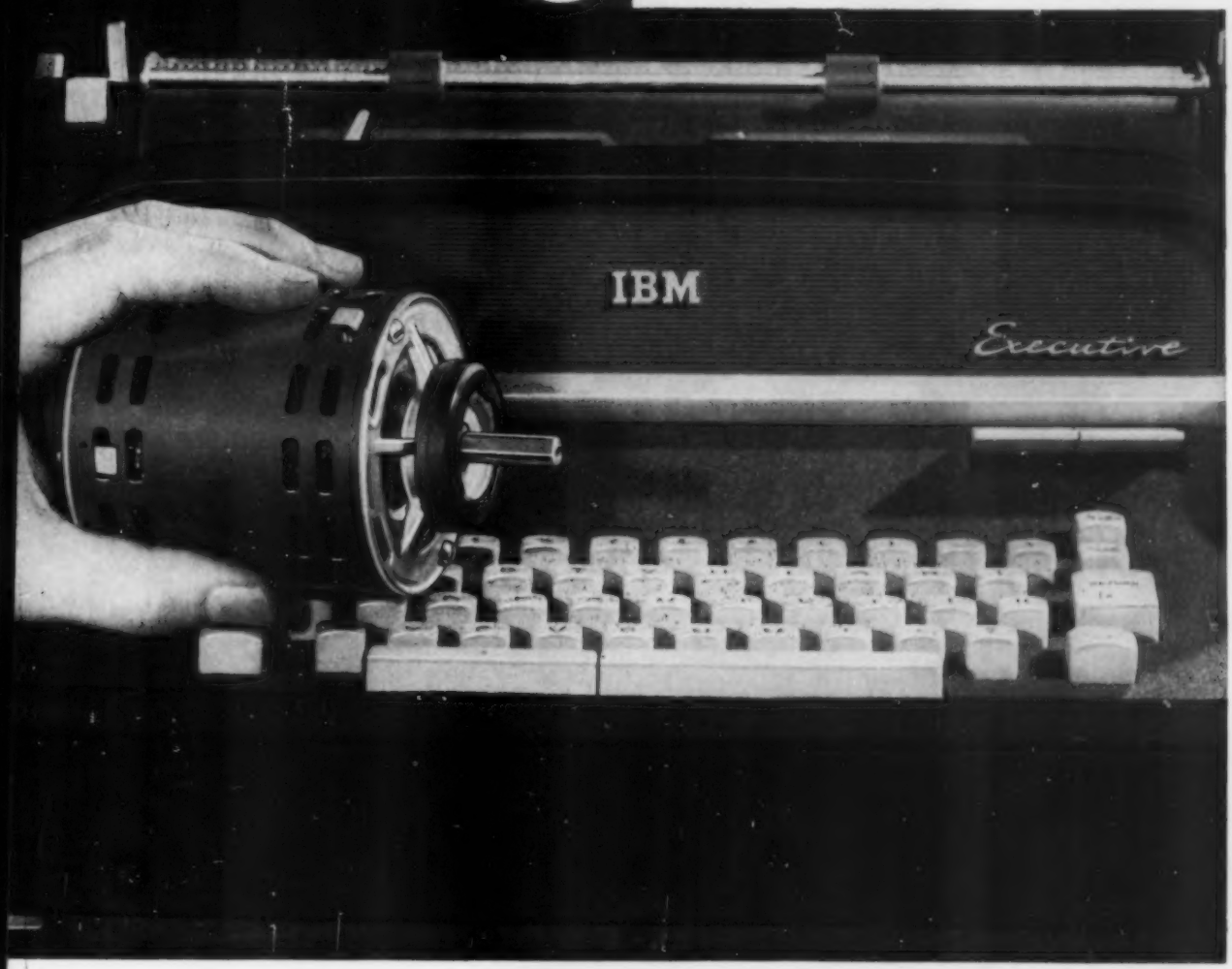
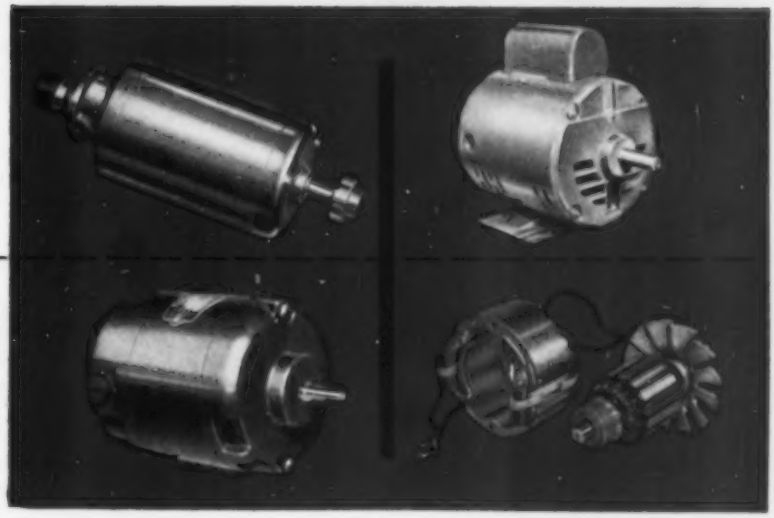
MOTORS 1/200 thru 1 HP

(other ratings up to 200 horsepower)



At left, Retractable Capstan Motor . . . shaft of this special R&M fractional HP motor rotates and also moves axially. Manufactured for IBM's 727 Magnetic Tape Unit.

At right, Standard Fractional HP Motors . . . a wide range of types, sizes and mountings for DC, single or polyphase AC; all standard voltages and frequencies.



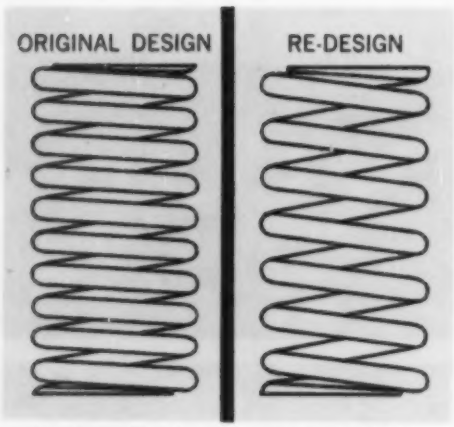
At left, Standard Universal Motors . . . ratings from 1/50 to 1/2 HP. Choice of end, pad or foot mountings to permit design versatility. Custom designs also available.

At right, Series Motor Parts . . . precision-made series, universal or polyphase high-cycle motor parts. All types and sizes engineered to your requirements.

CIRCLE 29 ON READER SERVICE CARD

70 POUNDS OF SPRINGS

were just going along for the ride!



10 coils—.120″ wire
130 lbs. of wire per
1M springs

7 coils—.105″ wire
60 lbs. of wire per
1M springs

Because of mounting cost conditions, a user of motor-support springs asked for a complete design check. Redesigned by A.S.C. engineers, required stresses were met by a slight change in wire size, allowing a reduction in number of coils from 10 to 7. This meant a saving of 70 pounds of material per thousand springs. Because of the shorter length of wire, coiling and grinding speeds were increased, heat-treating time reduced. Saving to the customer—40%.

How about the springs you use? A consultation on your specifications costs you nothing. Just contact any Division of Associated Spring Corporation. For a handy reference to spring action, write for "Spring Design and Selection—in brief."

6804

Associated Spring Corporation

General Offices: Bristol, Connecticut

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B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
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Cleveland Sales Office, Cleveland, Ohio
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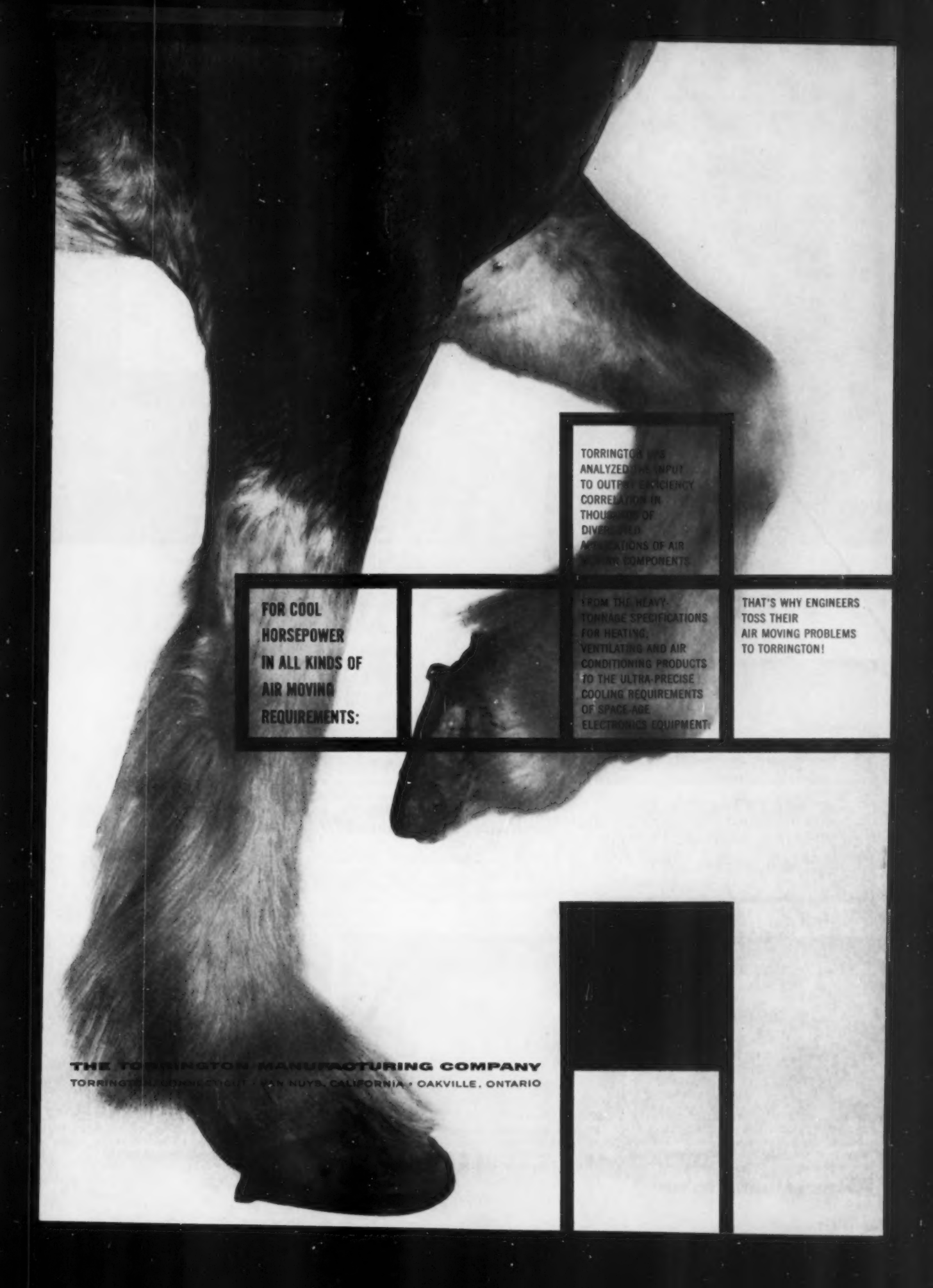
Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.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TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

Designed to give you *Double Protection!*

WAGNER TYPE DP MOTORS

PROTECTED against corrosion...

PROTECTED against splashing liquids...

WM59-9

Wagner Type DP Motors provide *double protection* that means longer life—more versatility of application. Rugged cast iron frames and endplates are highly resistant to corrosion. Dripproof enclosures are so well designed that these motors can handle many applications that formerly required splashproof motors. These motors pack ample power into little space, are light in weight and are easy to maintain.

SLEEVE BEARING MODELS AVAILABLE. The entire line of ratings is available with ball bearing construction, or with steel-backed, babbitt-lined sleeve bearings of high load carrying capacity that provide quieter operation.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

Branches and Distributors in All Principal Cities

Wagner Electric Corporation

6406 Plymouth Ave. • St. Louis 14, Missouri

DOUBLY PROTECTED—Air intakes and outlets are positioned to provide complete protection against dripping or splashing liquids. Rugged cast iron frames protect against rough handling and corrosion.

CIRCLE 32 ON READER SERVICE CARD

COOLING RUNNING—Specially designed baffles, which protect the stator windings, direct a cooling stream of air through the motor to effectively cool the motor—add to motor life.

CAN BE RE-LUBRICATED—Original factory lubrication will last for years in normal service—but grease plugs are provided to permit re-lubrication that adds years to motor life under severe conditions.

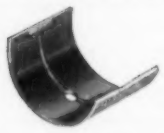
Solid bronze, steel or aluminum
Steel lined with bronze, babbitt, copper or aluminum alloy
Plain or ball indented
Oil holes, grooves, slots, notches as required
Straight, clinch butt or special seams
Many lengths and diameters

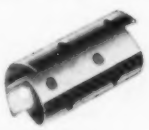
LOW COST BUSHINGS with Bearing Performance!

Bimetal bushings, in a variety of alloys on steel, provide bearing load-carrying qualities, *with the advantages of low-cost production*. Quality-controlled manufacturing to your specifications. Complete engineering service. Write:

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN


Copper-Alloy Lined


Spacer Tubes

Bearing-Surfaced Thrust Washers

Aluminum or Babbitt Lined

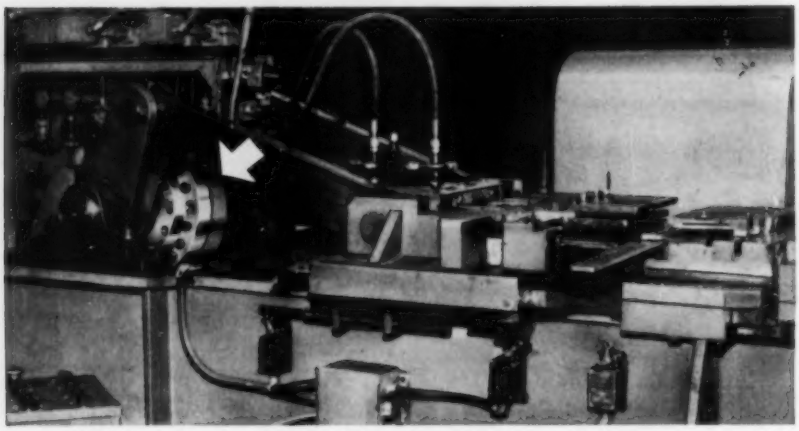
FEDERAL Mogul SINCE 1899

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

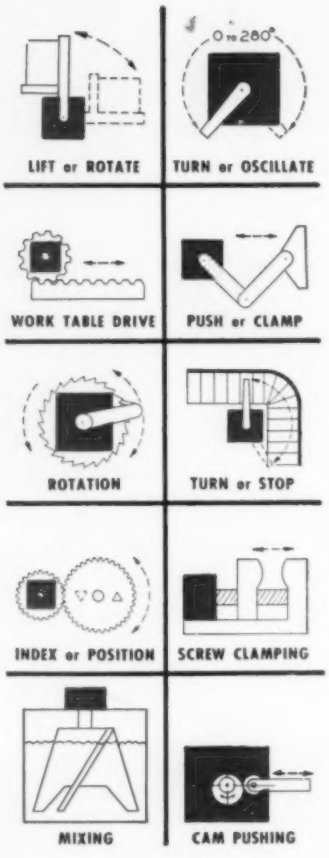
RŌTAC®

EXERTS 60-TON FORCE

. . . *In 1/6th the Space of a Straight-line Actuator!*

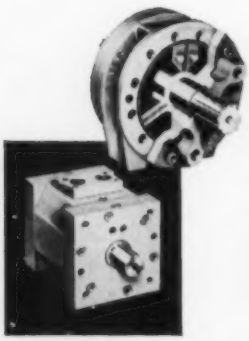


Left: **Every 1½ minutes, a Model HN Rōtac Torque Actuator on this wire-forming machine exerts a 60-ton force on the work through a simple toggle arrangement. Higher torque and higher speed—in a fraction of the space required by a straight-line power unit, control valves and motor—add up to Rōtac efficiency! (Photo courtesy Stubnitz Greene Corp.)** ***Below:*** **These typical Rōtac applications might suggest the answer to your design problem:**



Rōtac Reciprocating Rotary Torque Actuators are designed to do more jobs that cannot be done easily or economically with other devices. **Torque** is instantaneous and uniform through the required arc. **Ratings** range from 100 to 40,000 inch-pounds for standard single-vane models, from 240 to more than 200,000 inch-pounds in double-vane models. **Power source** can be air, oil or other fluids, with operating pressures to 1,000 psi in standard Rōtac units. **Mounting** can be vertical, horizontal or at any angle, and RN models can be safely manifold mounted. **Rotation or oscillation** (to 280° in single-vane models) can be stopped, started, slowed down or speeded up. **Application** is unlimited; among hundreds of uses are mobile installations, machine tool and various light and heavy industrial applications. **Construction** conforms to J.I.C. standards, and to Ex-Cell-O's own high requirements for precision, long life and low maintenance. **Special designs** available for unusual applications, military and aircraft use. **Delivery** of a wide range of standard catalog models is fast. See your local Rōtac Representative or write direct.

59-R-2



FREE DESIGN DATA BOOK—20 PAGES

Contains everything you'll want to know about RŌTAC—How it works • Control • Typical applications and special uses • Installation details • Dimensions • Torque ratings.

EX-CELL-O CORPORATION

Greenville Plant, 945 E. Sater St., Greenville, Ohio

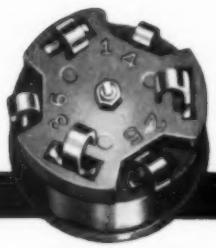
XLO

EX-CELL-O FOR PRECISION

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • THREAD AND GROOVE GAGES • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

UNIVERSAL WINDING COMPANY

Safeguards Against Motor Burnouts...



by Specifying and Using 3-Phase Motors with Built-in KLIXON PROTECTORS on UNIFIL Loom Winders

The Unifil Loom Winder, introduced by Universal Winding Company after years of research and development work, is meeting unprecedented reception as a new concept of filling yarn preparation for the textile industry.

This new machine has, since its inception, featured a KLIXON-protected 3-phase motor.

Universal Winding, like many other manufacturers, has found that motors with built-in KLIXON Protectors:

- Eliminate motor burnouts
- Increase motor output under adverse operating conditions
- Simplify motor controls
- Reduce motor installation costs, repairs and replacements
- Save on production down time

Because KLIXON 3-phase Protectors are responsive to both current and temperature, motors will not burn out from overheating . . . but instead they handle any load condition under any surrounding temperature condition.

KLIXON Protectors safeguard motors against the following conditions:

Prolonged overloads, unbalanced voltage, stalling, failure to start, increase in ambient temperatures, lack of ventilation, plugging or reversing duty, single-phasing.

KLIXON Motor Protectors are available for 3-phase motors ranging in size from fractionals up through $7\frac{1}{2}$ h.p.

Get full details from your motor salesman, or write for your copy of Bulletin PR-1243. Then specify motors with KLIXON Inherent Overheat Protectors. The savings you receive more than offset the slight additional cost.

METALS & CONTROLS

3812 FOREST STREET, ATTLEBORO, MASS., U.S.A.
A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

Spencer Products: Klixon® Inherent Overheat Motor Protectors
Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

CIRCLE 35 ON READER SERVICE CARD

CIRCLE 36 ON READER SERVICE CARD→

Naugatuck KRALASTIC

RESIN-RUBBER COMPOUNDS

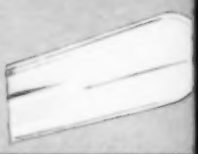
KRALASTIC molding and extruding compounds are unique combinations of thermoplastic resins and nitrile rubber. The result is an almost indestructible end product of exceptional strength, toughness and impact resistance.

Extruded as plastic pipe, Kralastic has proved phenomenally successful and durable in transporting salt water and sour crude in the oil fields; carrying natural gas, drinking water, corrosive chemicals, irrigating water; and as money-saving, quickly-installed electric conduit.

With the recently introduced Kralastic HTHT (high temperature, high tensile) and the dramatic new Kralastic MM, a compound so tough, so resistant to heat, staining and abrasion it rivals nylon, the Kralastics offer molders and users everywhere a combination of properties that is truly exceptional.

Consult us for experienced application advice, for information on independent test results, for whatever assistance you may require.

Helmets of practically e description are lightwe colorful, easily molded, and impact resistant as Kralastic can make them.



PROPERTY	UNITS	ASTM TEST METHOD	KRALASTIC B	KRALASTIC F
PHYSICAL				
Specific Gravity (Natural Color)*			1.06	1.04
Impact Strength (¼" Bar Sample)				
Izod Notched, 73°F.	ft. lbs./in. notch	D256-56	5-9	3-6
Izod Notched, 32°F.	"	"	1.8	1.5
Izod Notched, —40°F.	"	"	0.6	0.4
Charpy Unnotched, 73°F.	ft. lb./in.	"	35-58	28-42
Charpy Unnotched, 32°F.	"	"	35-50	40-45
Charpy Unnotched, 0°F.	"	"	35-50	21-26
Charpy Unnotched, —40°F.	"	"	8	6-8
Compressive Strength	psi	D695-54	6,400	5,800
Compressive Modulus	psi	D695-54	290,000	280,000
Flexural Strength	psi	D790-49T	8,000	7,500
Flexural Modulus	psi	D790-49T	260,000	250,000
Tensile Strength	psi	D638-52T	5,500	5,000
Hardness, Rockwell	R Scale	D785-51	96	92
Thermal Coefficient of Expansion	in./in./°F.	D696-44	0.000056	0.000056
Thermal Conductivity	B.T.U./hr./ft.² per°F./in.	C177-45	1.7	2.0
	Cal/sec./cm²/°C./cm		0.00060	0.00069
Specific Heat	B.T.U./lb./°F.		.37	.36
Deflection Temperature, 264 psi	°F.	D648-45T	187	185
Water Absorption, 24 hrs.	% Gained	D570-54T	0.3	0.2
Compression Ratio (Bulk Factor)		D392-38	1.8-2.0	1.8-2.0
Compression Molding				
Temperature	°F.		325-400	325-400
Pressure	psi		1000 +	1000 +
Injection Molding				
Temperature	°F.		375-600	350-600
Pressure	psi		6,000-30,000	6,000-30,000
Mold Shrinkage (Average)	in./in.		.004-.005	.004-.005
Extruding Temperature	°F.		350-450	350-450
Calendering Temperature	°F.		350-400	325-400
ELECTRICAL				
Dielectric Strength Short Time ⅛"	Volts/Mil	D149-55T	312	351
Volume Resistivity (35% Relative Humidity at 73°F.)	Ohm/Cm.	D257-54T	1.8×10^{13}	1.1×10^{13}
Dielectric Constant		D150-54T		
60 CPS		"	4.76	4.15
1000 CPS		"	4.45	4.20
10^6 CPS		"	3.78	3.61
3000×10^6 CPS		"	2.76	2.70
Dissipation Factor		D150-54T		
60 CPS		"	0.021	0.015
1000 CPS		"	0.002	0.002
10^6 CPS		"	0.026	0.026
3000×10^6 CPS		"	0.006	0.006
Loss Factor		D150-54T		
60 CPS		"	0.101	0.062
1000 CPS		"	0.010	0.007
10^6 CPS		"	0.099	0.094
3000×10^6 CPS		"	0.016	0.015

*Specific gravity of colors will vary with the pigmentation used.

†Heat distortion of 225°F. is obtained by annealing for 2 hours at 220°F.

These KRALASTIC materials are arranged in order of decreasing Impact Strength except J, L and HTHT, which have special outstanding properties.

Pipe, valves, and fittings of Kralastic are extremely tough, noncorroding, easy to install, approved for drinking water. A proven superior product in over 9,000 miles of installation.

Large formed parts have high dimensional stability, excellent resistance to most chemicals, and high mechanical strength even in thin sections.

Distinctive Properties:

- High impact resistance
- Extreme toughness combined with hardness
- Lightweight: ⅛ weight of aluminum; 1/7 weight of iron
- Noncorrosive, nonelectrolytic
- Readily sawed, drilled, and threaded
- Quickly solvent welded
- Dimensionally stable over a wide temperature range
- Opaque built-in colors

Major Uses:

- Pipe and pipe fittings
- Light wheels, gears and pulleys
- Durable hair combs
- Machine housings and parts
- Textile warp tubes and bobbins
- Radio and camera cases
- Football and safety helmets
- Tote boxes
- Hose nozzles and fertilizer injectors

KRALASTIC 2907	KRALASTIC MM (Formerly Kralastic 2590)	KRALASTIC D	KRALASTIC J	KRALASTIC L	KRALASTIC HTHT
1.06	1.07	1.05	1.02	1.02	1.08
1.5-3.5	0.7-1.5	0.4-1.3	6-9	5-7	3-4
1.8	0.7	0.4	5-6	3-5	2.0-2.5
0.3-0.8	0.4	0.4	1-3	1.5-2.5	0.3-0.5
30-50	20-30	23-33	25-35	30-45	30-50
—	—	23-33	25-30	—	20-30
—	—	10	—	30-40	15-25
25	20	8	35-40	30-40	10-15
10,500	11,000	9,000	4,000	5,600	10,000
350,000	370,000	430,000	190,000	200,00	290,000
11,500	13,500	11,500	4,000	6,500	12,000
400,000	450,000	390,000	170,000	275,000	370,000
7,800	8,800	6,500	3,000	4,000	8,000
115	118	108	62	88	116
0.000042	0.000032	0.000047	0.000073	0.000048	0.000038
1.6	1.8	1.7	2.1	2.3	2.5
0.00057	0.00062	0.00058	0.00072	0.00079	0.00086
.37	.38	.37	.38	.40	.37
198	200	193	172	175	225†
0.3	0.3	0.2	0.2	0.2	0.2
1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0
325-400	325-400	325-400	325-400	325-400	350-500
1000 +	1000 +	1000 +	1000 +	1000 +	1000 +
375-600	350-600	350-600	350-600	350-600	400-600
6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000
.004-.005	.004-.005	.004-.005	.004-.005	.003-.004	.004-.008
350-400	350-450	350-450	350-450	350-450	400-500
—	—	325-400	300-375	300-375	—
385	386	350	340	384	363
$>2.7 \times 10^{15}$	$>2.7 \times 10^{16}$	$>10 \times 10^{13}$	0.54×10^{13}	1.3×10^{13}	$>10 \times 10^{13}$
3.17	3.10	3.41	4.00	3.70	3.54
3.12	3.08	3.54	4.47	3.52	3.43
3.08	3.02	3.20	4.05	3.48	3.24
—	—	2.66	2.80	—	—
0.005	0.004	0.009	0.011	0.073	0.034
0.005	0.005	0.002	0.002	0.008	0.012
0.009	0.010	0.017	0.018	0.020	0.021
—	—	0.003	0.008	—	—
0.016	0.012	0.030	0.043	0.270	0.120
0.016	0.015	0.005	0.010	0.028	0.040
0.028	0.030	0.053	0.072	0.069	0.067
—	—	0.009	0.021	—	—

United States Rubber

Naugatuck Chemical Division, NAUGATUCK, CONNECTICUT

Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

The Panelbuilder

87 YEARS OF SERVICE
CUTLER-HAMMER
CONTROL
C-H

News for and about Panelbuilders

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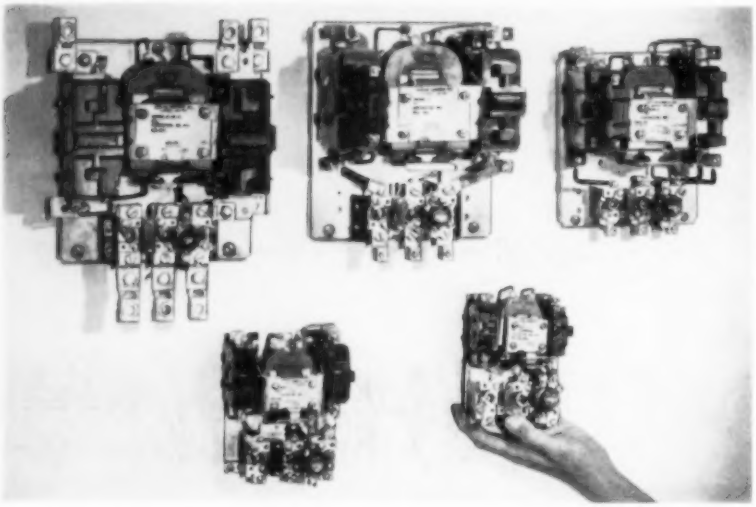
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.



COMPLETE LINE OF DEPENDABLE CONTROL COMPONENTS CUTS PANEL ASSEMBLY COSTS

Panelbuilders using Cutler-Hammer Three-Star Motor Control report it provides important savings in the time and effort required to layout, mount and wire their panels. Ready-to-mount Cutler-Hammer Starters and Contactors are available in NEMA sizes 0 through 4 for all non-reversing, reversing, and multi-speed applications.

Simplified Installation

Regardless of the size or type, all Cutler-Hammer Starters and Contactors use the same time-saving methods of key-hole mounting and straight-through wiring. Sure-grip terminal connectors hold wires securely even when different sizes are used. Indestructible molded magnet coils are color coded for quick voltage and frequency identification, and to interchange coils only a screwdriver is needed.

Dependable Performance

Repeated tests reveal Cutler-Hammer Components provide substantially greater electrical and mechanical life. Vertical dust-safe contacts stay clean, free from the ravages of arcing and pitting caused by dust contamination. Light weight, short stroke movable contact members hold the inertia effect to a bare minimum resulting in far less contact bounce and mechanical wear. Magnet armatures pivot smoothly on hardened bearing surfaces, avoids the uncertainties of sliding friction.

Complete information on all panel mounting Cutler-Hammer Control Components is contained in the latest edition of the Panelbuilders Handbook.

PANELBUILDERS HANDBOOK SIMPLIFIES SELECTION OF ELECTRICAL COMPONENTS

This handy 80 page reference guide is specifically edited to assist design engineers and control panelbuilders in the selection of electrical control components and control accessories. Every effort was made to make this book as concise as possible, and yet it includes such vital information as wiring diagrams, dimension drawings, ratings, ordering information and a maintained price list.

Address your request for a personal copy on your company letterhead. Ask for the Publication EE120-Y249 . . . Cutler-Hammer Inc., Milwaukee 1, Wis.

NEW OIL-TIGHT POTENTIOMETERS

Cutler-Hammer recently announced the addition of oil-tight potentiometers to the very popular line of 10250T Oil-Tight Pushbuttons, Indicating Lights, Selector Switches, etc. Complete, ready-to-mount units are available in three models . . . a single element 2 watt potentiometer, a dual element 2 watt potentiometer, and a single element 25 watt potentiometer. All three models are so designed that they can be either base or one-hole mounted. Base mounting of the control units is gaining preference among panelbuilders and machine designers because it eliminates "hinge wiring" usually associated with one-hole, cover mounted control units. The new Cutler-Hammer Oil-Tight Potentiometers are easy to install and index. The operating knob, indicator

ring, and sub-panel operator are independently adjustable, permitting rapid, sure alignment of all three. The out-front position of the indicator ring is another plus feature of design. One glance and the machine operator is sure of the exact setting . . . no stooping, no parallax, no guessing. For detailed information on the new Cutler-Hammer Oil-Tight Potentiometers and other 10250T control units write on your company letterhead for the Master Design, Pub EL178-Y249.

DEVELOPMENTS TO WATCH...

New data on beryllium-nickel alloy performance . . .

. . . at elevated temperatures (at least to 1500 F) are being assembled by Brush Beryllium Co, and will be available "within the next few months." Hot tensile and hardness data for both cast and wrought alloys of the general composition 2 to 3% Be, are being assembled and will be made available by the company. The alloys are precipitation-hardening materials that have a room-temperature tensile strength of 120,000 psi as annealed, which can be raised to 280,000 by heat treatment.

Nuclear-process heat reactors will be designed . . .

. . . to supply 100,000 to 250,000 lb of steam/hr at pressures to 600 psi and will be a combination of nuclear and conventional units if the AEC follows the recommendations of an industry-advisory group which met last month in Washington.

The group split about equally on a steam pressure range of 0 to 250 psi and 250 to 600 psi, plumped strongly for the 100,000 to 250,000 lb/hr capacity.

Asked whether nuclear-process heat would eventually be "most feasible in plants using nuclear heat only, nuclear as base load with conventional power plants for peak loads, or nuclear for full loads with conventional for standby," the group split almost evenly. Fewest votes, though (about 25%) went to the all-nuclear plant. This obviously points to a long-term need for small conventional equipment—and an opportunity for special designs.

Zirconium alloys with greater strength and heat resistance . . .

. . . are reported both by Japanese and Soviet metallurgists. They've been seeking ways to overcome the adverse effects of nitrogen on zirconium's oxidation resistance, and to increase its hot hardness.

In the first category, Jin-ichi Takamura and Yasuo Sasaki say that phosphorus, in amounts ranging from 0.03 to 0.06% by weight, may be the answer. It seems to counteract the nitrogen effect.

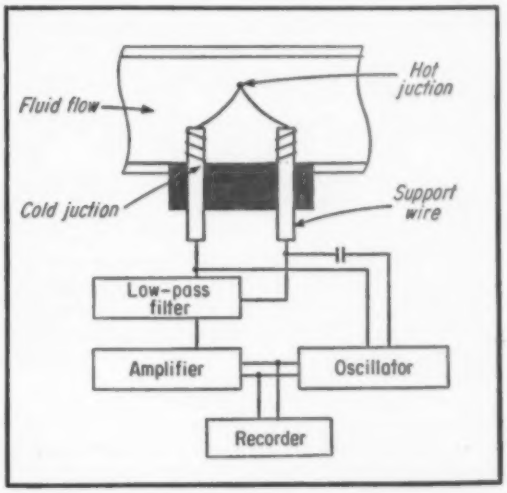
The Soviet metallurgists, O. S. Ivanov and A. T. Semenchenkov, find tin additions (in amounts to 4%) increase both resistance to nitrogen damage and mechanical strength. Molybdenum, too, can improve mechanical properties, though it decreases corrosion resistance.

Japanese metallurgists Yuzo Hosoi and Norio Nagata have been investigating these two metals, and several others, including aluminum, as a means for increasing the hot hardness of zirconium. Molybdenum, they say, does the best job at temperatures below 750 F; while aluminum has the greatest beneficial effect above 1100 F. However, rate of cooling may alter the results considerably. They noted several transitions as the alloys were slow-cooled or quenched.

A thermoelectric flow-measuring device . . .

. . . that can detect small and rapid changes in flow rate has been designed in Sweden. It takes advantage of the fact that the amount of heat conducted away from a heated junction immersed in a fluid is affected by variations in the rate of flow of the fluid. Measuring fluctuations in heat transmission therefore indicates variations in fluid flow.

Central element of the new device, says Claes Allander of Stockholm, is a copper thermocouple, energized by a high-frequency oscillator. Dc generated by the thermocouple is fed through a low-pass filter, converted, amplified and then fed back to control the h-f current and keep the hot-junction temperature constant. This holds the hot junction at a temperature about 40 F above that of the cold junction which is at the same temperature as the fluid being monitored.



Thermoelectric circuit is diagrammed here.

DEVELOPMENTS TO WATCH...

Triple-action adhesives . . .

. . . better able to serve as vibration dampers and electrical insulators as well as bonding agents are coming from several sources. By making adhesives do double or triple duty, it's hoped additional insulation and damping can be provided without markedly increasing structural dimensions.

For instance, at the last SAE Aeronautic meeting, Prof B. J. Lazan of the U of Minn suggested that properly-engineered adhesive layers might provide increased vibration-protection in airframe construction without adding to size and weight (*PE—Oct 26, p 35*).

Tests of one adhesive, now on the commercial market, Prof Lazan says, showed it to have a vibration-damping factor "about 100 times larger than that of a 'typical' structural metal at its fatigue limit;" plus an ability to stand cyclic shear.

Interface adhesives selected for greatest possible damping ability, he believes, can make a significant contribution to the structural system.

As a specific example of what an engineered adhesive can do, W. J. LeBrun of Lawrence Adhesives cites the case of the laminated iron housing for a large magnetic flowmeter. Here, it was not only necessary to provide a "stronger-than-metal" bond for the core laminations but also to prevent shorting between them, and to protect them from vibration. In this case, a special epoxy adhesive did the trick.

Tighter thickness specifications for sheetmetal . . .

. . . could save a lot more than they cost—in flight vehicles, at least, G. A. Hoffman of Rand Corp told last week's ASME meeting.

Variations in sheet thickness that make over-size specifications necessary can add as much as 650 lb to an airplane's weight. It would cost about $2/sq ft to obtain 0.063 and 0.020-in. aluminum in tolerances of ±0.002,0 and 0.000,7 instead of 0.004 and 0.001. With each pound of structural weight costing $10 to $30,000 in terms of payload weight, this expenditure seems more than worthwhile.

Holding such missile materials as titanium to similar tolerances would cost about $5/sq ft; but would save more than 0.02 lb/sq ft in weight.

Assuming just 1000 sq ft, the saving would be 20 lb. Assuming a payload cost of $700 per lb of structural weight (within the range of present-day commercial craft) that means a saving of about $14,000—far more than enough to justify the $5,000 cost of the tighter specifications.

A new radiation hazard . . .

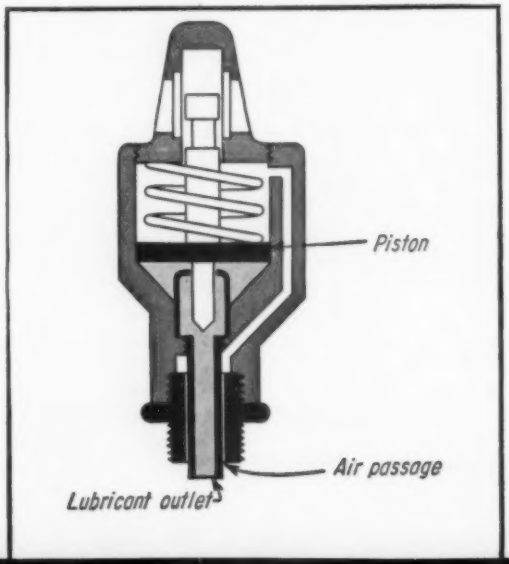
. . . is troubling the Navy. This time, it's not atomic radiation; but radio frequency energy.

Radio waves as a source of radio interference are an old story. The trouble now is that electromagnetic radiation from radar and radio has also been found to have an unfortunate ability to play hob with naval ordnance. It can set off rockets, shower dangerous high-intensity sparks on equipment and personnel, and activate electrical blasting caps—a fact the explosives industry itself discovered some time ago.

Now, the Navy has initiated a study of RF sensitivity of all ordnance equipment with the aim of setting standards to guide future design. BuShips is in charge of the project.

Automatic lubricator for pressurized stuffing boxes . . .

. . . and for elements that operate below atmospheric pressure, has pressure-balancing passages to compensate for atmospheric pressure changes, or internal vacuum or pressure conditions. Designed by Thirion, 11 rue de Lessard, Rouen, Seine-Maritime, France, it is a spring-loaded dispersing device, essentially standard in design except for the nozzle and pressure equalizing system. —ARG



Air passages and pressure-balancing chamber are designed to assure uniform dispersion of lubricant despite pressure variations.

Exhibition Reveals Italy's Strides in Electronics

Olivetti unveils fully transistorized computer; Offiicine Guardigli, photoelectric feed for rolling mills

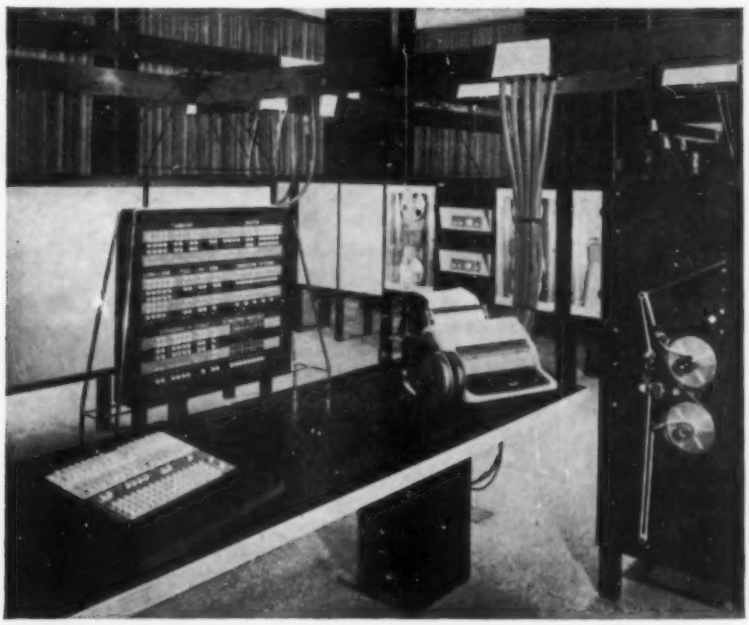
MILAN, ITALY—The 4th Milan Automation and Instrumentation Show was notable this year for its display of new, large-scale electronic equipment. The big items included computers and systems for controlling machine and process industries, and somewhat overwhelmed the bulk of the exhibits —pneumatic, electromechanical, electrohydraulic and electronic instruments for controlling temperature, pressure, level and other physical parameters.

Italian firms appearing in the show were especially noteworthy for the technical strides they have made over the past year. Olivetti, for example, introduced its new Elea 9003—the first electronic computer entirely Italian-made. It is a fully transistorized arithmetic computer for processing data and solving operational and research problems. The Olivetti machine is pluri-sequential—that is, it will handle more than one program at a time and an automatic priority system can phase in three programs simultaneously without interruption or overlapping.

The internal memory unit for retaining program instructions and storing information employs ferrite core magnetic components for high-speed processing. The memory unit has capacity of 160,000 characters, but can be enlarged by adding magnetic drum memories.

Input information is entered with punched tape, punched card or magnetic tape. The computer records results on teletype or punched card. The Elea also has off-line equipment to convert punched tape or cards to magnetic tape which will retain information for processing at a later date. Its photoelectric reader handles 800 characters/sec or 700 cards/min. A fast teletype—also off-line equipment—gives speeds varying between 600 to 800 lines, 120 symbols each, a minute.

In machine tools, Olivetti introduced an automatic electrohydraulic milling machine with electronically controlled fixed program for series production of breaker-arm support plates for the power industry.



First all-Italian computer . . .
is an Olivetti triumph, that was a major attraction at Milan Show. Various components of the computer system are connected by overhead air cable ducts supported by a trestle. This aerial network, which eases physical shifting of computer parts, is operated from a keyboard-type manual control panel.

ELECTRONICS FOR STEEL MILLS

Officine Guardigli of Milan showed a new control system for metering steel as it passes through reciprocating rolling mills. A photoelectric device, which registers motion of rolling-mill carriage, has a registering ring that presses against the rolling-mill thrust piston and transmits piston motion to a soup-plate shaped wheel with several slits around its rim. The slits alternately intercept and interrupt the light beams of three photocells—*A*, *B*, and *C*—above the wheel. For every 5 mm movement of the piston, the photocells signal three impulses in the order *A*, *B*, *C* for forward motion or *C*, *B*, *A* for backward motion of thrust piston. These forward and backward impulses are transmitted to a meter which indicates net movement of the rolling-mill carriage at 5 mm intervals from start to stop.

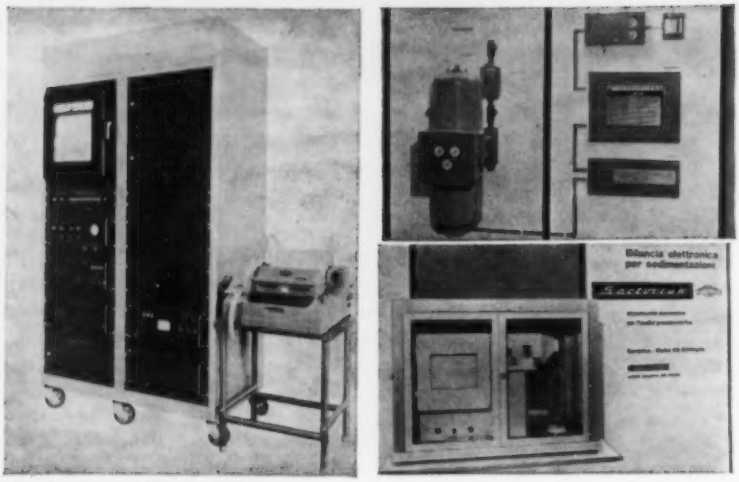
For process industries, Carlo Erba, Milan pharmaceutical and chemical firm, exhibited a new electronic sedimentation scale for granulometric analysis, which is made under license from Sartorius-Werke A. G. Gottingen, Germany. The firm also displayed a chromatograph of its own design, the Fractomatic Model 110, for continuous and automatic plant stream monitoring.

The Sartorius scale automatically records increasing weight of sediments deposited on the scale plate as a function of time. The resulting graph shows granulometric distribution of sediment within limits of 1 to 60 microns.

Impulses from the automatic recorder are supplied by a photocell which operates a tripper. Intensity of photocell beam, hence trip activity, is proportional to accumulated sediment. After proper amplifications and compensations, the tripper in turn activates a device that regulates movement of plotting apparatus.

GAS-MIXTURE ANALYZER

Erba's Italian-designed Fractometer



Other pace-setting displays . . .
included a centralized data-logger for continuous record of test or process information (left), a French entry by Intertechnique of Versailles; an electronic sedimentation scale (right) developed by Germany's Sartorius-Werke and licensed by Carlo Erba of Milan. Fractomatic-110 (top), a chromatographic gas analyzer for process industries was both developed and manufactured by Carlo Erba.

is based on the adsorption or partition methods of gas chromatography and is composed of analyzer, control and recording units. It is mounted in a cast aluminum housing suitable for hazardous areas. Upper portion of the housing contains a thermostatic chamber with sampling device, detector and chromatographic column. This column is spiral shaped and mounted on a metal cylinder kept at constant temperature by an electronic controller.

The lower portion of the housing contains the electronic thermoregulator, the carrier gas-flow control device, and a two-way valve to introduce the gas stream from the plant into the apparatus and auxiliary circuits. The control unit programs the various operations of the analysis cycle with a special adjustable timer and cams. This unit also contains a transistorized dc power supply for the detector, automatic zero-setting device, and auxiliary control and indication circuits. Results of the analysis are plotted on a strip chart potentiometeric recorder.

The Fractometer can be equipped with a special calculating unit suitable for insertion in the automatic control circuit of the analysis process. This unit contains an electronic integrator and four memory complexes. Together they give a continuous visible and analogical expression of four selected components from the mixture under analysis.

The device will find application in a butadiene and ammonia synthesis plants; in control of gaseous hydrocarbon, flue and cement-furnace gases and plant atmospheres; and in chlorine production, polymerization, and isomerization processes.

SNO-CATS Napping

Being railroaded to the Antarctic are these Model 843 SNO-CATS built by the Tucker Corp of Medford, Ore. Vehicle is powered by a 6-cylinder, turbo-charged diesel which develops 175 hp at 2500 rpm, 407 ft-lb torque at 1750 rpm. Transmission consists of 5-speed forward, one speed reverse with syncromesh in 3rd, 4th and 5th gear. Over-all height is 10 ft, 10 in., interior height of cab is 71 in., over-all width is 9 ft, 5 in. and over-all length is 24 ft. Fuel capacity is 80 gal, consuming one gal per mile over average terrain with a 70% load. Body construction is of all-welded steel tubing with aluminum skin and fiberglass or styrofoam insulation. Accessories include 24-v alternators, radio suppression, 24-v diesel oil fired heaters, and suitable winch.

DATA LOGGER MAKES DEBUT

Among foreign exhibitors, Intertechnique of Versailles, France, made history with first public appearance of its automatic data logger, the ENA-11. This equipment will keep a continuous log of critical test or process data and will also compare the data with alarm levels. A certain number of scanning cycles can be stored for further printing by off-limit control or at operator request. Data is recorded on typewriter or punched tape.

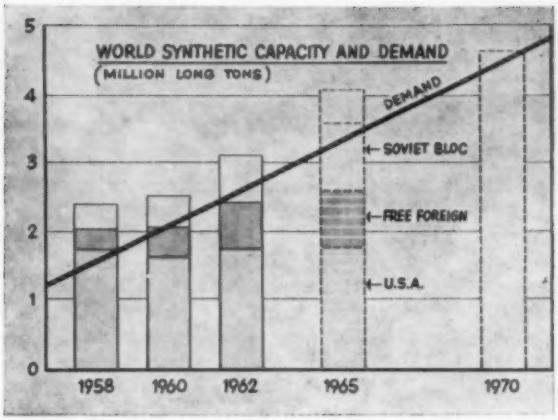
For continuous logs, input signals are sequentially connected to the corresponding input module by the central programmer on the basis of data set by the operator. An analog-to-digital converter translates this data to digital code, then prints or punches it on tape.

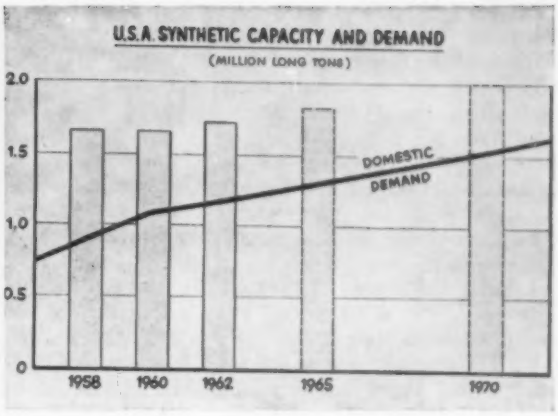
For monitoring alarm levels, the central programmer scans input signals and shunts them to the corresponding input module. This data is compared with alarm values by a sensitive amplifier—a polarity detector indicates off-normal signals. These off-normal points are signaled by red light and an alarm. The red light remains lit as long as the input is improper.

ENA-11 is assembled from transistorized electronic circuits, ferrite memory cores and hermetically sealed electromechanical devices. Plug-in printed circuits call for miniaturized components and semiconductors. Electromechanical circuits use plug-in, hermetically sealed relays.

The data logger is expected to find application in wind tunnels, engine test facilities, nuclear energy plants, public utilities, chemical plants, refineries and pipeline systems.

—Gene DiRaimondo





New Types Help Synthetic Rubbers in Drive to Big Lead Over Naturals

NEW YORK—World production of synthetic rubber will more than double in the next 10 years while production of natural rubber remains at about current level, George R Vila, a vice-president of US Rubber Co, told the Rubber Manufacturers Association meeting here. He further predicted "that the hazy line now separating plastics from rubber will be completely erased, and that the rubber manufacturer will have an ever-widening array of raw materials, thanks to technological advances in polymer chemistry."

By 1970, Vila said, world rubber consumption will reach 7 million long tons but natural-rubber production will have leveled off at 2.3 million tons annually. This will leave the gap to be closed by synthetic rubber. A surplus of synthetic rubber will exist because of the "bold planning" by American synthetic-rubber producers. This excess will serve as a hedge against possible delays in Soviet-bloc production, or a breakdown of supplies of natural rubber from Indonesia.

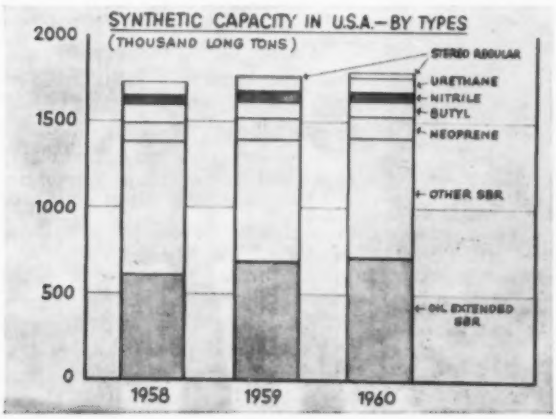
Pointing to the estimated 4.7 million tons of synthetic-rubber output predicted for 1970 production, Vila expects natural rubber will hold only a third of the total rubber market. In the US, Vila said, the gap will be even greater—about 3 lb of synthetic for each lb of natural.

Newest of the synthetics to hit the market are the "stereo-regular" polymers. Their rubber molecule configuration is orderly, or regular, and can be controlled in a predetermined manner, hence the name. Natural rubber, too, is considered a "stereo-regular" polymer. By contrast, the molecule in SBR rubber is comparatively disorderly and haphazard. Some of the stereo-regulars are replacing natural rubber in applications such as heavy-duty tires; others will make a strong bid to take a share of the SBR outlets as new polymerization techniques challenge established emulsion methods.

Meanwhile, research is finding solutions to many of the vexing problems facing the already established synthetics, thus widening their horizons. Nitrile types continue to make inroads on natural-rubber applications with the introduction of polymers having better weathering characteristics plus color stability. Neoprene is being substituted, to some extent, for natural rubber in white-wall-tire sidewalls because of good ozone resistance. Butyl rubber is expanding into the fields of curing bags, wire and cable insulation, molded and extruded goods, and newer halogenated types —with reportedly unusual properties —are entering the markets. ■

Top US High School Teachers to Take Sabbatical at Stanford

STANFORD, CALIF—Some 48 crack US high school mathematics and chemistry teachers will be selected to spend a sabbatical year at the university here taking graduate work in their

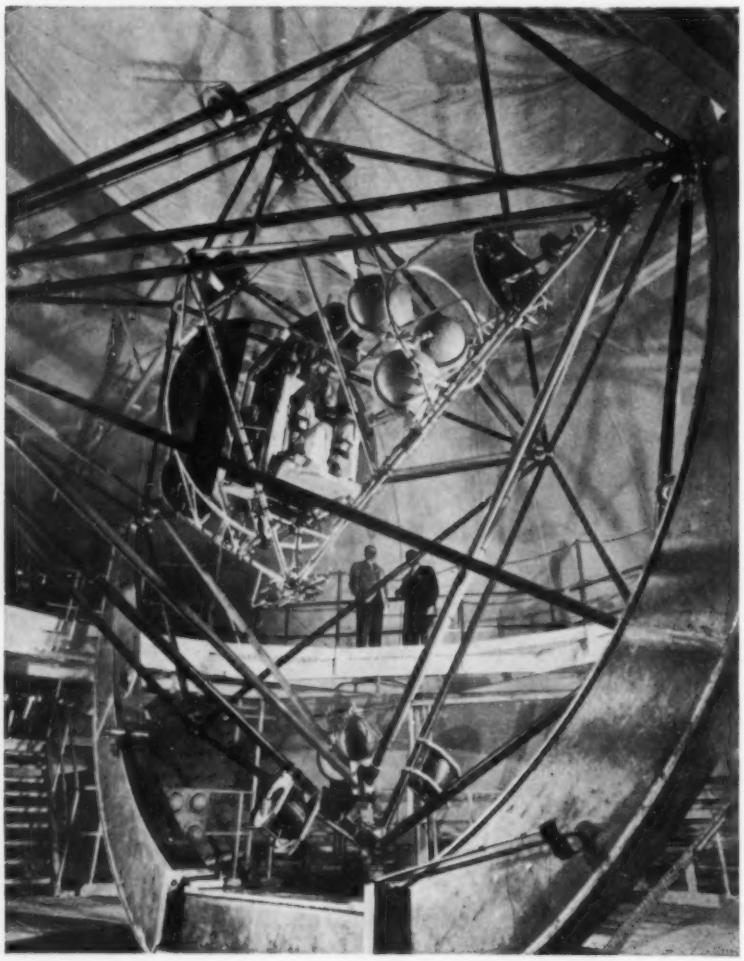


own fields. The program will commence Sept, 1960.

Supported by individual $3000 grants from the National Science Foundation, the participants will be given additional allowances for dependents, books and travel. They will take specially planned courses taught by members of the Stanford faculty. Some may be selected to do additional work during the summer of 1961.

Stanford is one of 33 colleges and universities participating in the NSF's $9,200,000 program, now in its 5th year. Stanford played host to a similar group of teachers during the 1957-58 academic year. ■

Double-purpose Space Test Rig



Multiple-axis test inertia facility in NASA's Lewis Research Center, Cleveland, altitude wind tunnel gives an engineer-pilot a wild ride. The three gimbal cages simulate all space flight attitudes—yaw, roll and pitch—for the space capsule mockup. Rig is designed to test pilot reactions to disorienting motions in space and for use in design of space orientation systems.

Secrecy a Feature of US-German Rotary-type Combustion Engine

NEW YORK—Besides the compactness, lightweight and high horsepower claimed for it, considerable mystery is a feature of Curtiss-Wright Corp's rotating combustion engine that works like a cross between a gas turbine and a reciprocating piston engine.

As described and exhibited at a press conference on Nov 23 by Roy T. Hurley, board chairman and president, the vibration-free powerplant has only two moving parts—rotor and crankshaft. Not revealed to questioners were exact performance details such as engine rpm and efficiency, torque characteristics, horsepower and weight. Hurley said other companies had not been sounded out as possible customers and that the government, too, had not been approached—but would be shown the engine later the same day.

However, Hurley did supply some figures: the engine weighs 1 lb per horsepower (exhibited was an engine said to produce about 100 hp); idling speed is about 300 rpm; fuel consumption about 0.45 lb/hp-hr with low-octane gas.

HOW IT WORKS

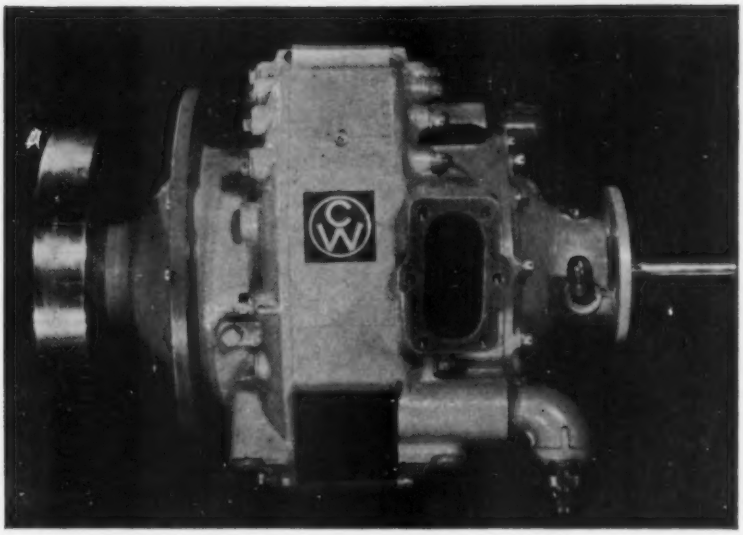
There was no doubt that the engine, developed jointly with NSU Werke, W. Germany, offers startling possibilities. It requires no valves, springs, camshaft, piston or connecting rods. An automotive carburetor supplies a mixture of gasoline and air into the combustion chamber through a sidewall port. As the rotor turns in the chamber, mixture is compressed and fired by a single sparkplug. Exploding gases deliver power to the crankshaft through the rotor. Exhaust fumes escape through a second port. Three power sequences per revolution maintain an almost continuous intake, compression, ignition, expansion and exhaust cycle.

The roughly triangular rotor is keyed to the crankshaft. Incoming gas mixture is trapped between rotor and chamber wall. Crankshaft is supported on bearings mounted in the end housings. Lubrication is through the crankshaft.

"Absence of rotating parts," Hurley said, "eliminates the vibration and assures smooth operation because of complete balance attained. Also, the lack of 'hot parts' such as exhaust valves and turbine blades, minimizes the use of expensive metals, and when coupled with the engine's simplicity, will make it low in cost."

FUTURE FOR THE ENGINE

C-W's present single-chamber engine develops about 100 hp, but four chambers ganged can produce about 700 hp, Hurley claimed. This is using



Compact and lightweight . . .
C-W's rotating engine is built around center-section combustion chamber, which contains exhaust port. Just above intake port is the sparkplug hole. Engine can be cooled by air or liquid. Claimed for single-chamber engine is 100 hp; extra chambers will increase power delivered to the crankshaft.

the present 15-in. dia (approximate) chamber. Two other sizes are contemplated: a smaller chamber for the 5-100 hp range; and a 1000 hp unit with a diameter of 25 to 27 in. If aluminum is substituted for the present grey iron housings, weight can be reduced to about ½ lb/hp, Hurley added.

Hurley explained that C-W has exclusive rights for the engine under patents granted and pending for aircraft use throughout the world, and exclusive rights for all other purposes in the US, Canada and Mexico. NSU has non-exclusive right to ship the rotating engine to North America when it is installed in NSU's own automobiles, motorcycles and scooters. It is reported that NSU is developing other low-horsepower applications, which will be announced shortly. Felix Wankel, associated with the NSU Werke, invented the principle from which the present engine has been developed and is working on the new NSU designs.

Hurley visualizes wide uses for the engine in all fields of transportation and industrial equipment. One of the first C-W applications will be in the Air-Car, followed by other planned consumer products requiring engine power. ■

Congress Probes Patent Rights

WASHINGTON—Two congressional committees are holding hearings this month on ownership of patent rights to discoveries made under governmental research contract. But their aims may be different.

The House Space Committee is concerned mostly with a request from the NASA (National Aeronautics and Space Administration) for more authority to permit the patent rights on work it finances to go to private industry.

A senate monopoly subcommittee on small business says its hearings will check, among other things, whether private ownership of government-aided patent rights costs the government added money. One subcommittee aide suggested in advance that all discoveries from government-financed research might be placed in a patent pool so all industry could benefit.

The 1958 Space Act lets the government retain patent rights on any invention developed under an NASA contract at government expense, although the NASA director may waive the government's claim in some instances. If the government retains patent rights, they normally are open for general use without royalty. ■

Proposal—Space Dept to Abolish NASA

WASHINGTON—Creation of a Department of Space, directed by a new secretary in the President's cabinet, is recommended by Washington's space-minded attorney, Ralph E. Becker. He proposed that the 61 organizations and committees now administering the nation's 67 rocket, missiles and space projects be lumped into one department "as a unified single force."

Becker, a member of the Rocket Society's Space Law Committee and of the Committee on Law of Outer Space of the American Bar Association, also urged that the NASA, now over-all boss of the civilian space program, be abolished through absorption into the new department. Similarly, the Department of Defense would be taken entirely out of the research, design and production of missiles and space vehicles. End-result would be "a single cohesive force with wasteful rivalries and duplication reduced to a minimum, and probable saving of billions of dollars." ■

COMING EVENTS

DECEMBER

8-10 . . . . 2nd Annual Conference on the Application of Electrical Insulation, Shoreham Hotel, Washington, D. C.

13-16 . . . . Materials Handling Institute, Annual Meeting, Savoy-Hilton Hotel, New York City.

JANUARY

12-15 . . . . Society of Plastics Engineers, 16th Annual Technical Conference, Conrad Hilton Hotel, Chicago.

15 . . . . Malleable Founders Society, Semi-Annual Meeting, Hotel Sheraton-Cleveland, Cleveland, Ohio.

25-28 . . . . Plant Maintenance & Engineering Show, Convention Hall, Philadelphia, Penna.

FEBRUARY

2-4 . . . . Society of the Plastics Industry, 15th Annual Technical and Management Conference, Edgewater Beach Hotel, Chicago.

3-4 . . . . Armour Research Foundation, 6th Annual Midwest Welding Conference, Illinois Tech Chemistry Building, Chicago.

Reader To Editor...

Ford Has Watercooled Engine

To the Editor:

I would like to call your attention to the feature on compact cars appearing in your Oct 5 issue, p 23. In the third paragraph you say that all engines of the vehicles are of aircooled design. This will no doubt demand a correction on your part by the men from Ford and Plymouth.

—Bob G Lift
service engineer
Holley Carburetor Co

• We erred. However, in the previous issue the write-up of the Ford Falcon was quite explicit in describing its engine as watercooled.—Ed.

The Age of Goofing Off

To the Editor:

Engineering, as with all other crafts, has been a great leveler—all people with the same job types, good, bad or indifferent, are paid the same salary. Every year companies bid to have the largest engineering depts thereby raising the starting salaries until there is very little if any difference in pay between a new engineer and an experienced man.

The other problem is that people have been told it is not polite to criticize. How do you convince a man he is not doing good work if you do not raise a ruckus, even a minor one. People who do fuss or ask why it takes a team and many conferences to design something as complex as a water faucet are shuffled to one side and a conformist is moved up. The new American way means conformity—the gray flannel engineer is King of the roost.

—Harold C Sanderson
Oak Ridge, Tenn

To the Editor:

Is it really the "Age of Goofing Off" (Oct 26, p 49) or the lackadaisical attitude of "I don't care, I'm getting paid whether I do a job or not; as for wages I can't complain since I don't really rate them?" Let's look at our present "Apprentice—Tool Maker or Machinist" program. Why should I be an apprentice for $1.85 an hour, when I can bluff my way through a job for 60 days at $2.75 an hour and classify as a General Machinist?

Those people in the upper brackets (Mahogany Row Areas) are practically at a loss to change the situation because of certain labor organization controls. And this is the vicious circle we live in; and as engineers must work in.

We have gotten completely away from designs and planning in detail parts or tooling that requires a "fool-proof" method. We are now at the "idiot-proof" era, What's next? Have we no pride in ourselves or our country? Or, is it just "I don't care, I'm eating well."? Quality? What's that?

—Vincent M Partsch, *prod engr*
Aerojet-General Co

Fitting Formulas to People

To the Editor:

According to Dr Suits' equation (Aug 24, p 4) where the number of time units required for n men to develop an idea is n^n), one person has one full and complete idea per unit of time and all the people in the world have never had a complete idea among them.

I cannot buy the first conclusion, but the second is intriguing. Do we not exist, advance and climb to the stars on half-baked ideas? Aren't the geniuses of this world the men who come up with 0.501-baked ideas?

—Richard A Sturley,
senior project engineer
Carrier Corp, Syracuse, NY

• Perhaps the following thoughts will get us out of the problem of 4000 years of civilization without a single complete idea.

Dr Suits' formula was simplified by arbitrarily assuming that n participants will produce no more or less than $1/n$ ideas each, per unit of time. If the number of participants and the fraction of an idea produced by each are not exact reciprocals, the equation no longer applies. If n is the number of participants and each has $1/m$ ideas per unit of time, a more suitable formula might be

$$\frac{m}{n} \times m^m$$

This seems more logical, because if 50 men each produce 1/10 of an idea per time unit ($m = 10$, $n = 50$) then the time required for an idea is 1/5 (10/50) the time necessary for each of 5 groups of 10 men to produce an idea.

As you increase $1/m$, the time to produce a full idea goes down very rapidly—which may explain why a little increase in intelligence makes for a very large increase in ideas.

The thing that troubles me about these formulas is their dependence on the time unit. Change ideas per minute to ideas per hour and everything seems to go haywire.—Ed.

To the Editor:

Dr Suits' formula does not bother me too much. Statistical formulas must be applied to statistical situations and I doubt that human beings can be made statistical in individual action.

My own problem is to take a small group of people and make sure that maximum usage is made of all our bits and pieces of ideas. Outside of work, I do a little with church, school and technical societies and here again the question is, how to make the best of ideas. We don't have too many Diesels or Einsteins in the world, but we can find many partial ideas. How then can we take our limited intelligence and make sure that we *add* partial ideas into full ones rather than *multiply* them until we have nothing. This is the problem of cutting a screw thread with greater accuracy than the leadscrew on the lathe. Call this creativity or common sense; if I can do it better I do my whole job better.

—Richard A Sturley,
senior project engineer
Carrier Corp, Syracuse, NY

• The problem of nurturing creativity is shared by most engineering managers, and it is one that has no easy solution. In our Sep 21 issue (*More Engineering per Engineer?*—p 32) the author wonders whether the engineer might not need a certain amount of routine to ruminate over a problem—that no man can be wildly creative every minute of the time.

But, he goes on to say, we can be certain creativity is affected by the conditions surrounding it. That is your responsibility as a supervisor, ours as editors writing to engineers, and all citizens to themselves and to the social "goods" and "bads" they settle on as custom.—Ed.

To the Editor:

In rereading the various articles certain thoughts, but no valid solutions, occurred to me. In recognizing my own limitations, how far can I go in appreciating and understanding greater "creativity"—capacity, ability—than my own?

All accomplishment in science and engineering is routine, but one man's routine is another's challenge. How much do we lose by not challenging every man and how do we do that? Creativity, on my level, is not creativity on yours. But, "'I'm just as big for me,' said he, 'as you are big for you.'"—R A Sturley
senior project engineer
Carrier Corp

Heated Windshield Wiper

To the Editor:

This is in reference to your "Why Don't They R & D?" column, p 59 of the October 5th issue. The article referring to the suggested electrically heated windshield wiper was of special interest because we built a working model approximately six months ago of a windshield in which we used this very type of wiper suggested.

The wiper was patented by James A Hamm from Bethlehem, Penna and we were given the contract to build the unit, and demonstrate the wiper under actual freezing conditions. It proved very successful and according to the latest information at least three companies are very much interested.—Clifford T Lynn
Bethlehem Pattern
& Model Shop
Bethlehem, Penna

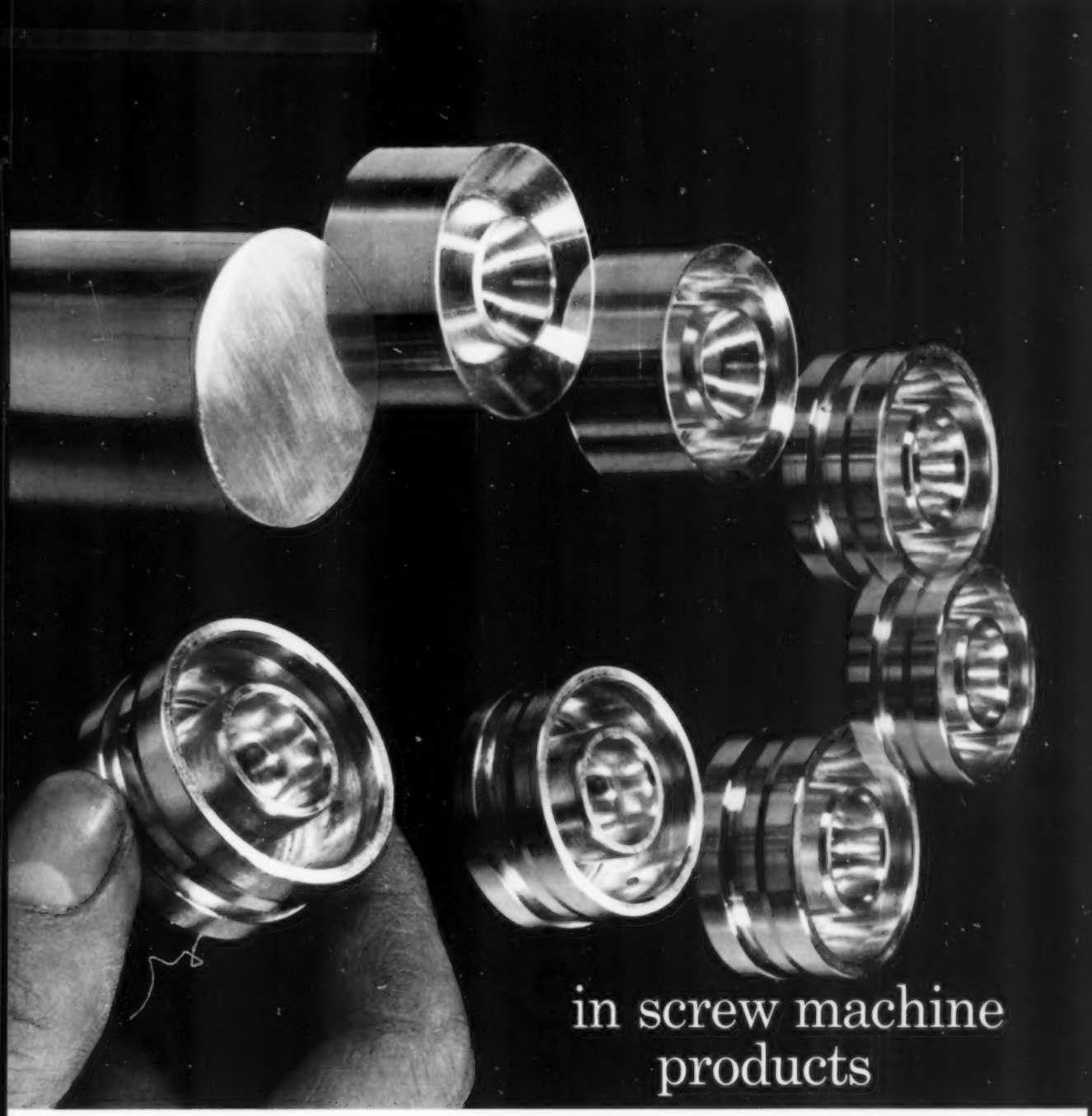
CORRECTION: In the article, "Hydraulic Servovalves," Nov 9, p 84, the equation for velocity-responsive damping force appeared as:

$$F_D = CwL \frac{dx}{dt} \sqrt{2 \Delta P \theta}$$

It should have read:

$$F_D = CwL \frac{dx}{dt} * \sqrt{2 \Delta P_\rho}$$

CIRCLE 47 ON READER SERVICE CARD→



Alcoa puts the metal where you want it

This aluminum piston for an automotive air-conditioning compressor shows how far Alcoa goes to put the metal where you want it. Not just in primary screw machine operations, complex and demanding as they were, but on through a series of exacting secondary operations that enabled us to deliver a completely finished part.

Using $1\frac{7}{16}$-in. diameter 2014-T4 cold finished bar on a six-spindle automatic, we handled the forming, trepanning, drilling, facing and counterboring. Then we tackled the rest of the job—drilling and deburring two $\frac{1}{16}$-in. cross holes. This was followed by coining the ball seat at a specified tonnage in order to insure proper assembly without distortion. Centerless grinding was then performed to a total tolerance of half a thousandth of an inch (plus or minus 0.00025 in.). All finished? Not by our standards. After final inspection, we cleaned every piece and packed it with meticulous care to prevent damage in transit, insuring safe and sound arrival.

Whether it's screw machine parts, forgings, castings, extrusions or impacts, Alcoa can put the metal where you want it—precisely and economically. The payoff may be fewer rejects, new flexibility in design, less waste in production, a best-selling product—or all four. To draw on Alcoa's file of ideas and Alcoa facilities, write today: Aluminum Company of America, 920-K Alcoa Building, Pittsburgh 19, Pa.

Alcoa puts the metal where you want it—in castings, forgings, impacts, extrusions and screw machine parts.

ALCOA ALUMINUM

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

Your Guide to the Best in Aluminum Value

News about COATINGS FOR METALS

from Metal & Thermit Corporation

Textured vinyl finishes now produced with sprayed coatings

To get a textured vinyl finish, designers are no longer restricted to laminated types. Two recent M&T developments in *sprayed* vinyl coatings make such appealing finishes especially easy to adopt. Actually, they *widen* the variety of patterns practical for metal panels, cases, housings and other parts.

TWO WAYS TO FINISH

Texture is produced chemically with *Unichrome Coating 6400*. Sprayed on smooth metal sheets and shapes, this coating gives a handsomely textured finish with warmth and leather-like appearance.

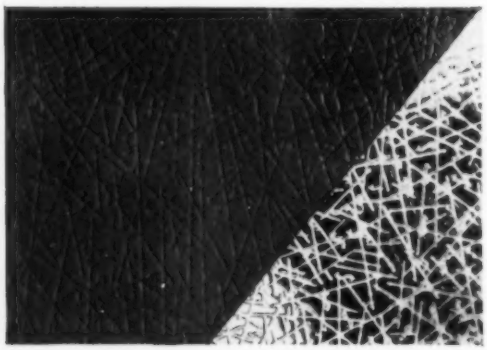
Unichrome Coating 6440 was developed for use on mill-patterned steel or aluminum, now becoming available in an increasing number of extremely attractive patterns. This coating does not alter the profile of the pattern. Whether applied thick or thin, it will faithfully mirror even the most delicate design rolled into the metal.

EXCEPTIONAL DURABILITY

Both of these sprayed vinyl coatings prove up to ten times more wear resistant than the usual baked textured enamel. In a recent evaluation for food shelves, M&T's *Coating 6400* withstood a half million "rubs" from canned goods and still looked new; the shelf with baked enamel showed wear after only 30,000 abrading strokes from the can.

Unichrome Coating 6400 sprayed on smooth metal develops a texture with the appearance of luxurious grained leather.

Unichrome Coating 6440, whether sprayed thick or thin, produces an exact replica of the metal pattern beneath it; also contributes warmth, color, and unusual protection.



The inherent chemical resistance in these vinyl coatings also protects against stains and corrosion. Their insulating qualities mean warmth to the touch, and also aid in sound-deadening.

As for production benefits, the sprayed finish eliminates the expensive scrap loss incurred with laminates; it also eliminates seam problems at joints.

For more details, write METAL & THERMIT CORPORATION, Rahway, N. J.

M&T coatings and finishes

METAL & THERMIT CORPORATION

CUT

LETTERING COSTS IN HALF WITH CLEARPRINT "FADE-OUT" PAPER GUIDE LINES IN TITLE BLOCKS AND ENTIRE DRAWING

	PART NO	DESCRIPTION
REQD 11/58	6304	R.M. Spring
	ODD DASH NUMBER SHOWN, NEXT HIGHER	

DIMENSIONS IN INCHES

FRACTION ±	TOLERANCES .X ±	.XX ± .03	.XXX ± .010	ANGLE ±

LAYOUT *See file 166-A*

CUSTOMERS SEE DWG 33644

DATE	6/19/58
DFTMN	JN
CHK	BJC
MATL	Spec. 104
STRESS	Std
SUPV	L.M.
PROD	H. Lame.
APPD	7/2/58

Vertical and horizontal guide lines are always the same on each and every sheet.

Horizontal lines are identically placed on every sheet, allowing you to design your Title Block as above for uniform lettering on every sheet. Horizontal lines on entire sheet save hours of LETTERING AND DRAFTING TIME.

Vertical lines are identically placed on every sheet and provide uniform guides for vertical layout.

Guide lines are on back of drawing surface enabling you to erase and erase without disturbing them!

Available in rolls and sheets up to 42" in width by any length with grids ruled 4 x 4, 5 x 5, 6 x 6, 8 x 8 and 10 x 10 lines to the inch.

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HERE'S YOUR PRINT

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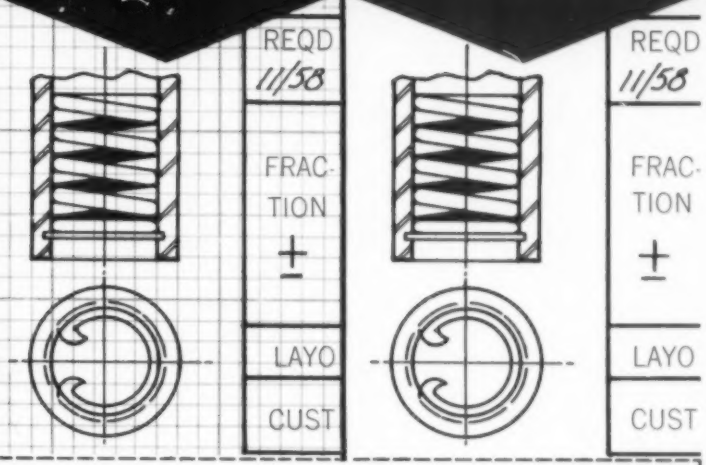

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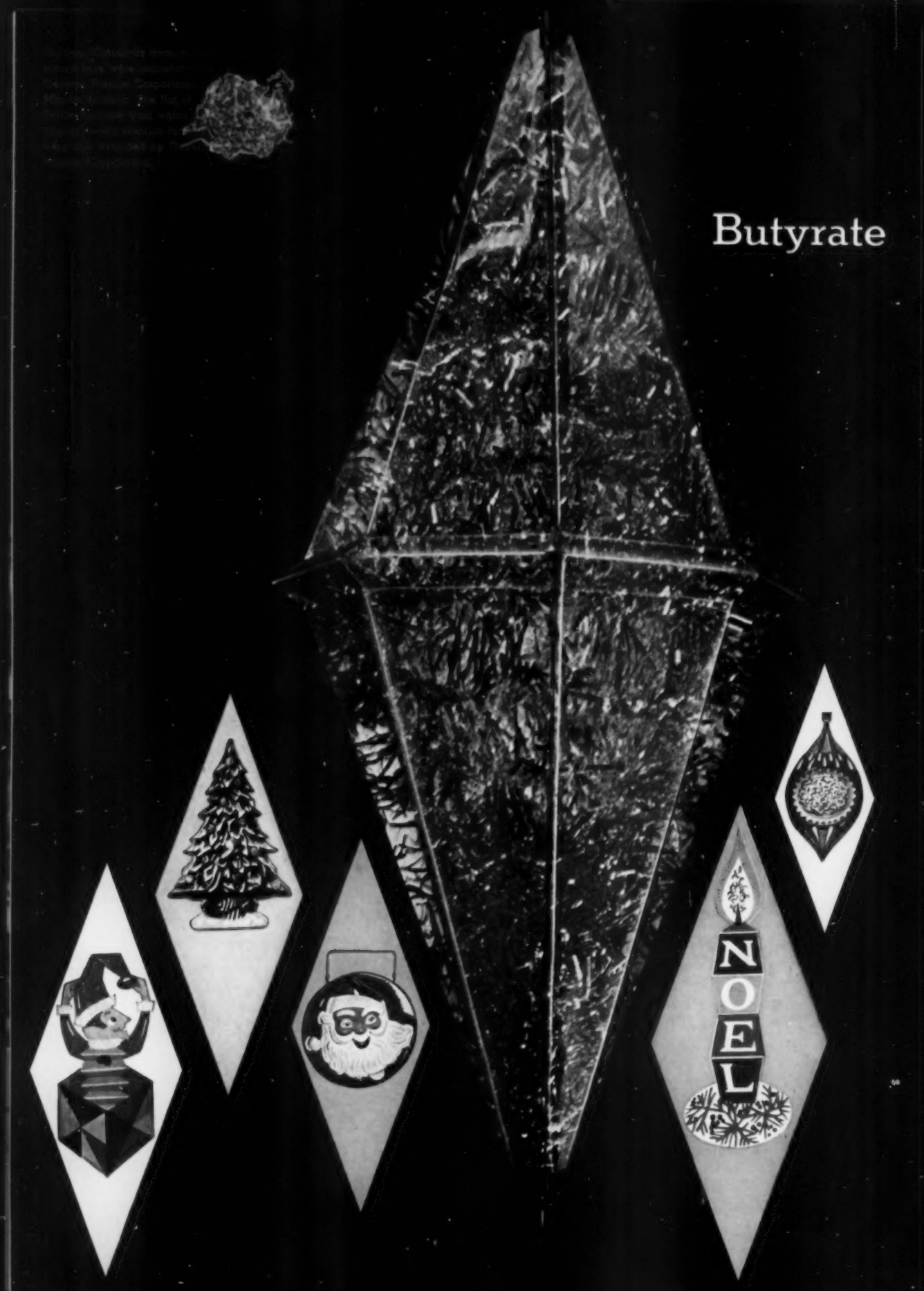

Butyrate
NOEL

gives the gift of long life
to giant outdoor Christmas decorations

Street displays made of tough, weather-durable Tenite Butyrate plastic help communities spread Christmas cheer for many years

When you need a plastic with long outdoor life, you find a ready answer in Tenite Butyrate.

Its durability has been proved by displays like these and by hundreds of other applications in many different fields, including such products as automobile taillight lenses, marine buoys, outdoor signs and oil-field pipe.

Yet, the outstanding weatherability of Tenite Butyrate seldom is the sole reason for its use. Rather, it is Butyrate's *combination* of properties that usually dictates its choice for a specific job.

The Christmas decorations shown here are an ideal illustration of how Butyrate's properties can be mated to the demands of a specific use.

Outdoor durability certainly is an important consideration for these decorations. Exposed to weather extremes ranging from sub-zero Alaska to sunny Florida, they must be able to endure in any location, showing excellent resistance to cracking, crazing or "aging."

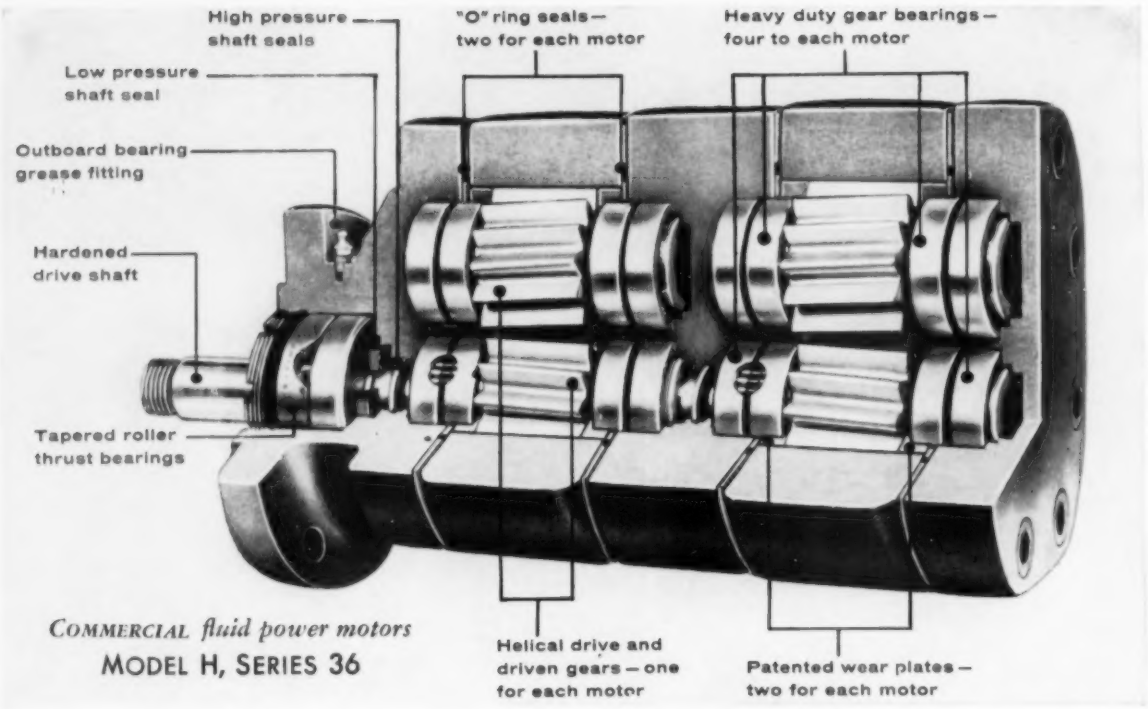
They must also be tough enough to take the abuse of repeated installation and dismantling, plus the hazards of storing and transporting.

Butyrate satisfies these requirements ... and other specifications of the manufacturer, such as availability in a crystal-like, clear-transparent formulation, resistance to yellowing by sunlight, and a high surface luster.

Fabricating advantages, too, complement the service excellence of Butyrate. Because of the ease with which extruded sheet of Butyrate can be vacuum-formed over inexpensive molds on fast-cycle machines, production costs are kept at a minimum. Even decorating costs are low; for the multicolored patterns are applied by silk-screening the inside face of the display before forming, thus protecting the printing from the weather and preserving a naturally glossy exterior. Subsequent fabricating operations such as trimming, punching, stapling, riveting or grommeting are easy to carry out without danger of crazing or cracking.

If you'd like to consider Tenite Butyrate for one of your material needs, let us hear from you. We'll be glad to discuss your application in confidence, and help you evaluate the suitability of Butyrate. For this assistance or for more information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE®
BUTYRATE
an Eastman plastic


High pressure shaft seals
"O" ring seals—two for each motor
Heavy duty gear bearings—four to each motor
Low pressure shaft seal
Outboard bearing grease fitting
Hardened drive shaft
Tapered roller thrust bearings
Helical drive and driven gears—one for each motor
Patented wear plates—two for each motor

COMMERCIAL fluid power motors
MODEL H, SERIES 36

How to get multiple "speed-torque" output

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

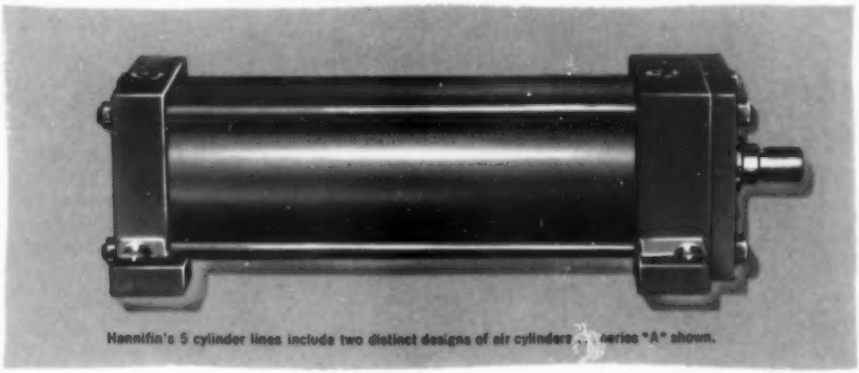
Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is help and assistance from COMMERCIAL's technical service department.

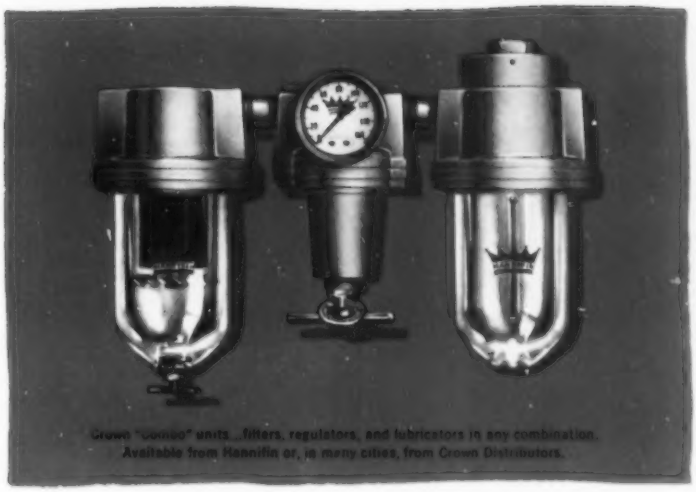
Address inquiries to Commercial Shearing & Stamping Company, Dept. G-50, Youngstown 1, Ohio.

COMMERCIAL
shearing & stamping

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS



Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only **HANNIFIN** makes all these **AIR POWER COMPONENTS**

Hannifin valves take many forms. This ⅜" 4-way valve out-performs many a competing ½" valve.

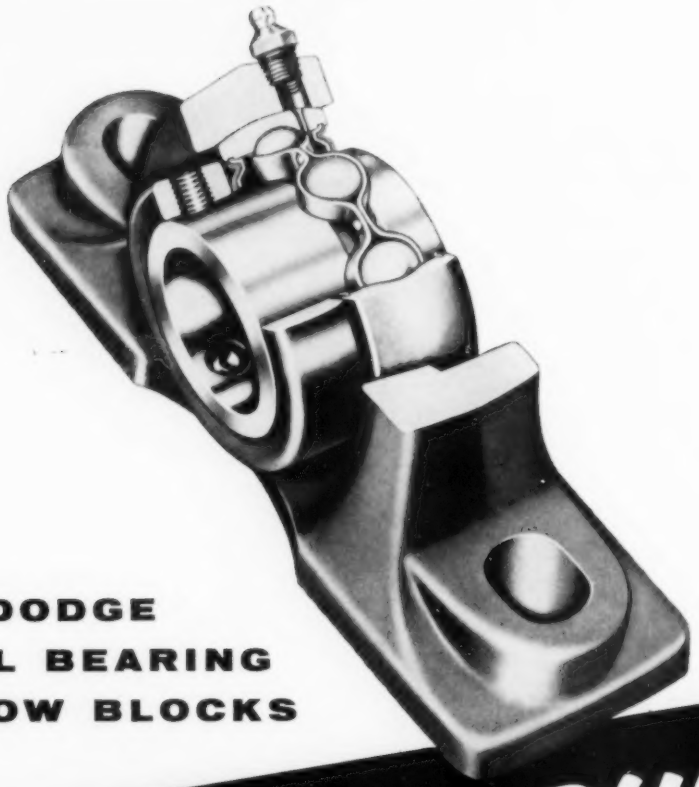
Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

HANNIFIN COMPANY

505 South Wolf Road • Des Plaines, Illinois

A DIVISION OF PARKER-HANNIFIN CORPORATION



DODGE
BALL BEARING
PILLOW BLOCKS

PRECISION BUILT
– for normal and medium duty jobs

SC

NORMAL DUTY
SHAFT SIZES — 1/2" to 2-7/16"

SCM

MEDIUM DUTY
SHAFT SIZES — 1-7/16" to 3-1/2"

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- ★ Long inner race distributes load over greater shaft area.
- ★ Metal backed synthetic seals are locked in position. They can't blow. Effectively exclude dust and dirt.
- ★ Completely sealed both on and off the shaft.
- ★ Fully self-aligning.
- ★ Rugged one-piece semisteel outer housing.

Pillow blocks, flange bearings, piloted flange bearings, cylindrical units, hanger bearings, screw conveyor hanger bearings.
Call your local Dodge distributor — or write us for technical bulletin.

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DODGE
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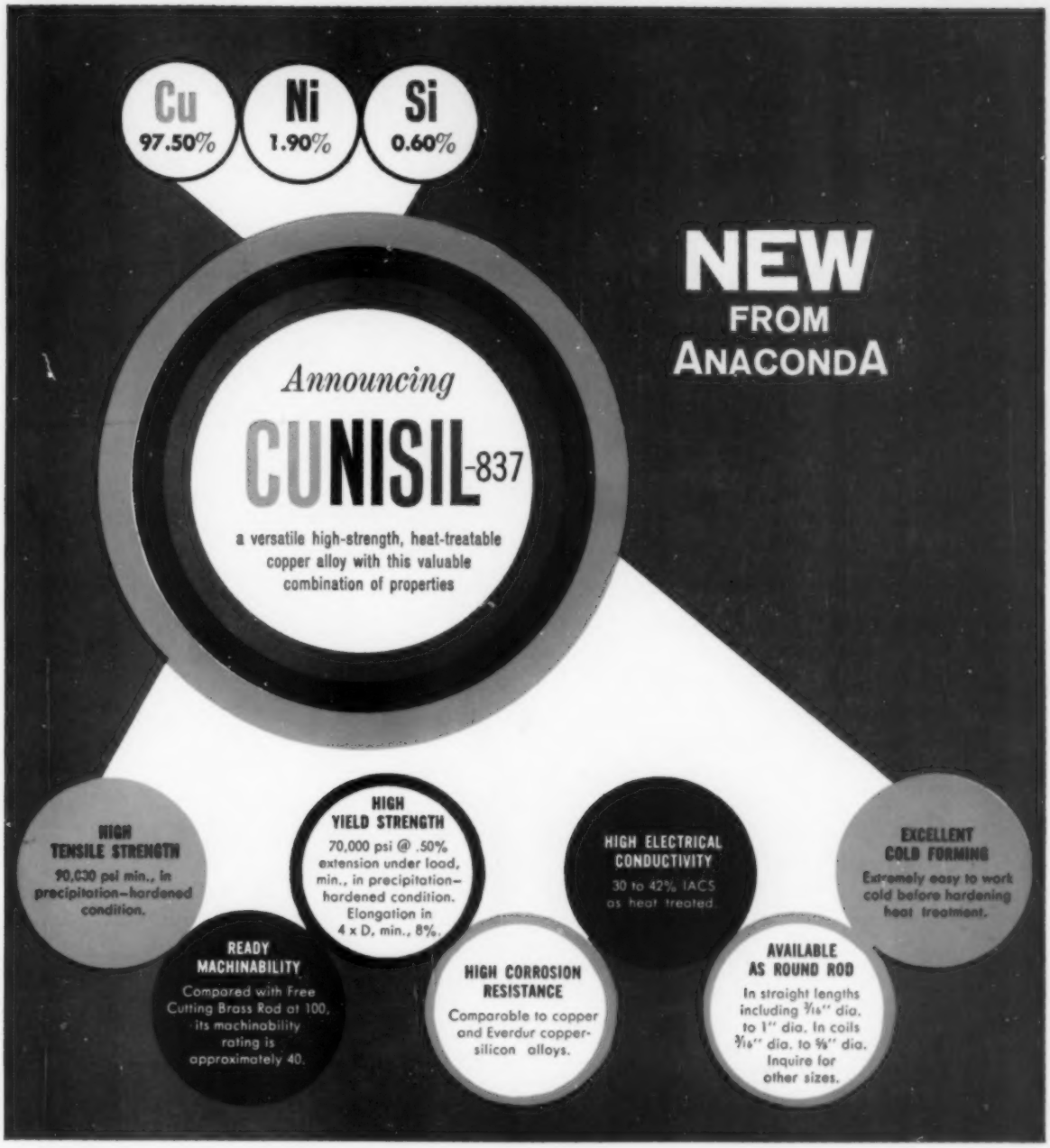

Cu
97.50%
Ni
1.90%
Si
0.60%
NEW
FROM
ANACONDA
Announcing
CUNISIL-837
a versatile high-strength, heat-treatable copper alloy with this valuable combination of properties
HIGH TENSILE STRENGTH
90,000 psi min., in precipitation-hardened condition.
HIGH YIELD STRENGTH
70,000 psi @ .50% extension under load, min., in precipitation-hardened condition. Elongation in 4 x D, min., 8%.
HIGH ELECTRICAL CONDUCTIVITY
30 to 42% IACS as heat treated.
EXCELLENT COLD FORMING
Extremely easy to work cold before hardening heat treatment.
READY MACHINABILITY
Compared with Free Cutting Brass Rod at 100, its machinability rating is approximately 40.
HIGH CORROSION RESISTANCE
Comparable to copper and Everdur copper-silicon alloys.
AVAILABLE AS ROUND ROD
In straight lengths including 3/16" dia. to 1" dia. In coils 3/16" dia. to 5/8" dia. Inquire for other sizes.

METALLURGICAL COMMENT. Most of the nickel and silicon in heat-treated Cunisil are present as an intermetallic compound, nickel silicide, and it is the precipitation of nickel silicide in the form of particles of submicroscopic size by a relatively low temperature heat treatment that accounts largely for the distinctive properties of the alloy.

Prior to the hardening heat treatment, the alloy is brought to a proper condition for hardening by giving it a solution anneal at a much higher temperature and then a quenching from this temperature; at this stage the alloy is quite soft and in a condition for drastic cold-working operations. The hardening heat treatment consists of heating at a controlled temperature for a definite length of time to obtain the desired mechanical properties.

CUNISIL-837 is a high-strength, corrosion-resistant alloy that includes many of the desired qualities of Silicon Bronze or Everdur®. Its applications to date have been primarily in the electrical equipment field.

FOR MORE INFORMATION—see your American Brass representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5947

ANACONDA®

Copper and Copper Alloy Mill Products

MADE BY THE AMERICAN BRASS COMPANY

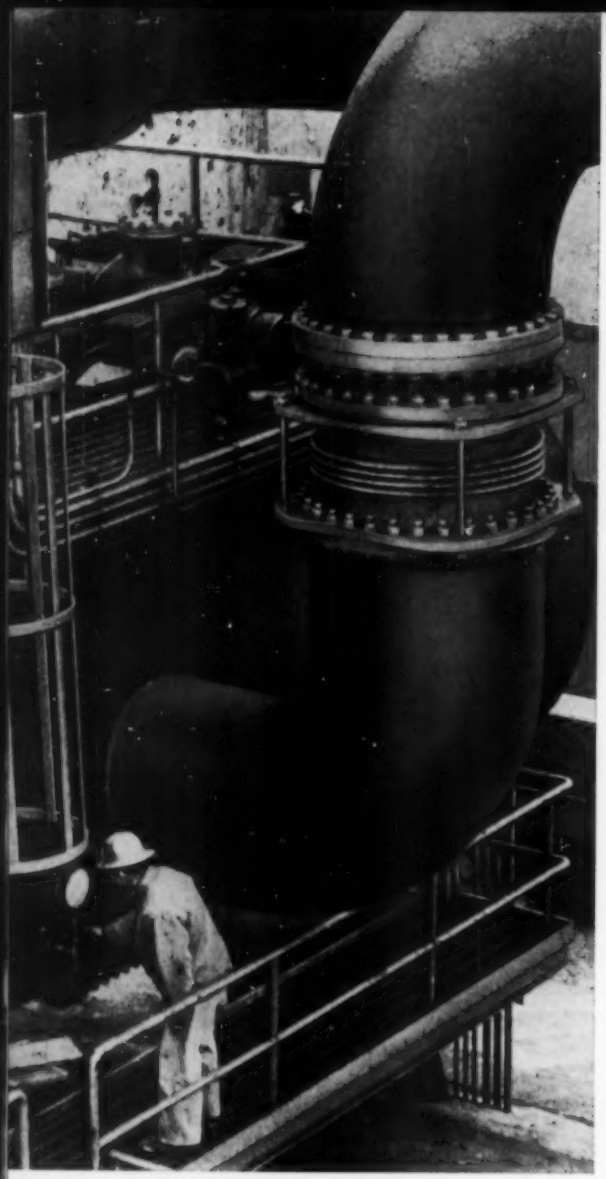
CIRCLE 55 ON READER SERVICE CARD 55

Form your own opinion A missile in flight? . . . A blacksmith's anvil? . . . The tail fin of an automobile?

STEELS FOR DESIGN

The "fin" is right—it is made of steel . . . ductile enough to stretch a point, yet strong enough to stand firm.

For some other formable examples of steel, turn the page ▷ ▷ ▷



Stainless Steel An expansion joint in a piping system absorbs movement which might otherwise result in reduced life or even complete destruction of vital equipment and piping. One of the best types is the flexible, corrugated Stainless Steel bellows type as manufactured by Zallea Brothers of Wilmington, Delaware.

To produce these bellows, a sheet of Stainless Steel is rolled into a cylinder and welded lengthwise by special automatic equipment. This cylinder is then formed within steel dies by imposing internal hydraulic pressures as high as 4500 psi while compressing the cylinder. The smoothly shaped, cold formed bellows which results are capable of absorbing many cycles of compression, extension, rotation or lateral deflection. Because the bellows are Stainless Steel, they are corrosion resistant, maintenance-free, and capable of prolonged service under severe temperature and pressure conditions.

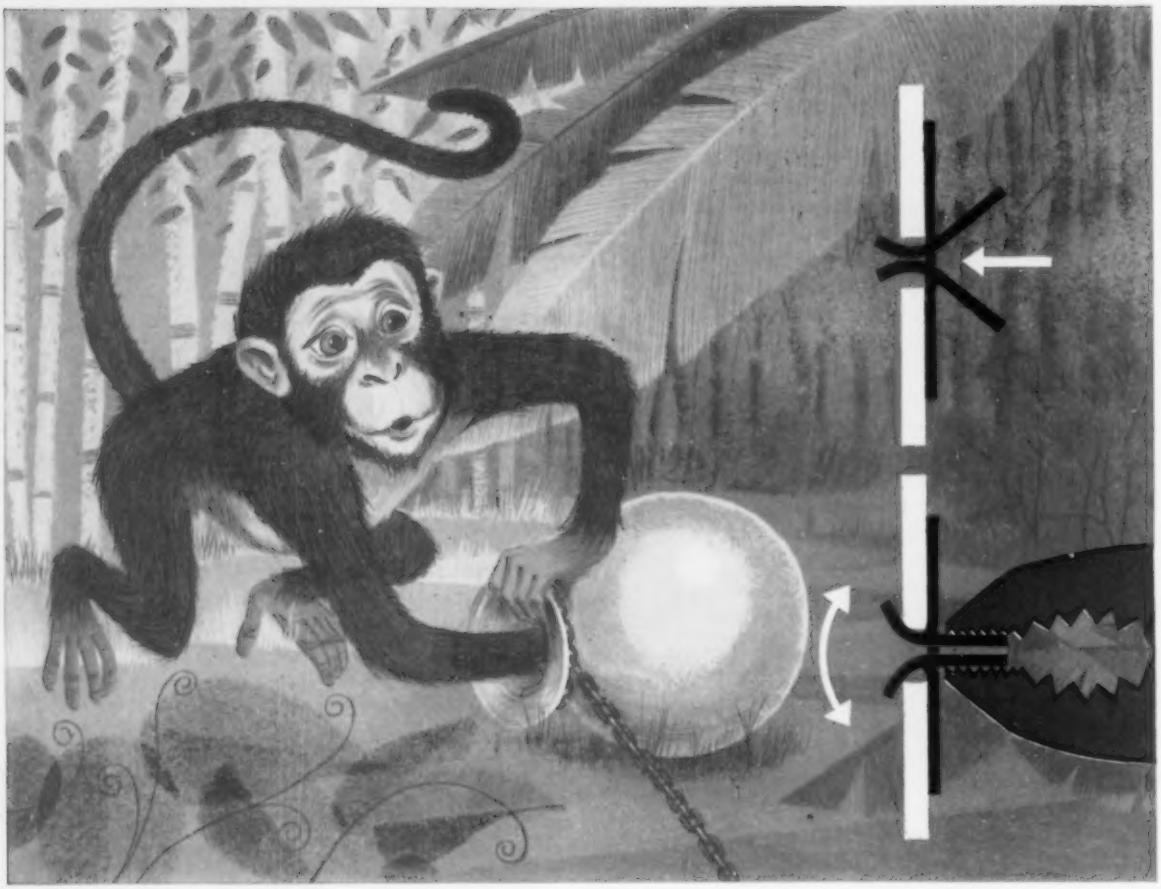
USS "T-1" Steel Shaped like a giant seashell, a turbine scroll case must withstand tremendous pressure. Water gushes through the conch in an ever-tightening spiral before shooting into the blades. Chicago Bridge & Iron Company used USS "T-1" Constructional Alloy Steel for the shells of four of the largest scroll cases in the Noxon Rapids Dam in Montana. Because of the exceptional strength of "T-1" Steel—115,000 psi minimum tensile strength—the walls could be made nearly 50% thinner and 50% lighter than carbon steel walls. Freight costs were lower. And because there was considerably less weight, the foundations for the cases could be made lighter and less expensive.

USS MAN-TEN High-Strength Steel Manufacturers have turned to high-strength steels to increase the strength of earthmovers without adding to their weight. LeTourneau-Westinghouse Company built their Model B scraper with USS MAN-TEN Low-Alloy High-Strength Steel in the yoke structure, side sheets, body truss tubes, and apron arms. MAN-TEN steel has a yield point of 50,000 psi—about 50% higher than carbon steel. This extra strength also permits designs with thinner, lighter sections that can reduce weight as much as 1/3 with no loss of strength. And though MAN-TEN steel is exceptionally strong, it is not difficult to form. In fact, MAN-TEN steel frequently simplifies fabrication because it can be used in lighter gages.

USS, MAN-TEN, and "T-1" are registered trademarks

STEELS FOR DESIGN

United States Steel USS



TRAPPED BY A GRIP THAT WON'T LET GO!

See how Tinnerman "pinch-grips" hold front-mounting attachments; no special equipment needed

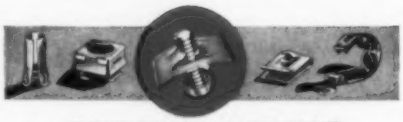
Typical of Tinnerman *new approaches to old problems* are "pinch-grip" SPEED CLIPS—permitting front-of-panel applications in a second's time. SPEED CLIPS are simply inserted into mounting holes and a plier's pinch gives permanent retention.

SPEED CLIPS can increase production rates, eliminate rejects, cut assembly costs as much as 50%. Many different features may be incorporated in the SPEED CLIP design to fasten cables, wire harness, rubber feet, mouldings, and for scores of other assemblies.

You may have a fastening problem that can be solved—or a product which can be improved—by this SPEED CLIP principle. Your Tinnerman specialist (see the Yellow Pages) can furnish samples and help you in many ways. Or write:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®



FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

Product Engineering

HORIZONS

December 7, 1959

COLD-WAR CREEP and FATIGUE

Every engineer knows about creep and fatigue, but apparently the lay public and many of our diplomats do not. These two phenomena, applied to American mettle, are the Soviet Union's basic tactics in the Cold War.

The idea is simple—just set up continual tension in international relationships, never near enough to the breaking point (Mr K hopes) to cause a visible crack or outright failure, but always there. Add a stress cycle for fatigue: tension in the Near East, the Far East, Europe, South America, Central America; compression in the UN, Tibet, India, Formosa, all along the borders of the Soviet Union. Plus a liberal dosage of concentrated stresses on sputniks, luniks, missiles, jet aircraft, international trade and other relationships to cause strains. An excellent atmosphere for creep and fatigue—and all at almost-normal international temperatures.

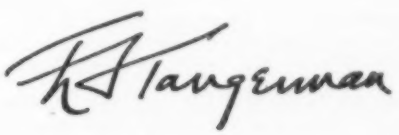
This technique is very simple for Russia's "calculated-risk" economy. Concentrate scientific and engineering talent on weapons, agriculture, mining, metals, basic machines; import the rest as and when you want to, or copy engineering advances where you can. That makes efficient use of manpower. Give the people only as much as you must to prevent vociferous dissatisfaction. Don't be concerned over step-by-step development; take a series of calculated risks.

Evidence? The relative freedom allowed visitors and the close control of foreign diplomats and correspondents. The careful sifting of Russians allowed to travel, with hostages kept at home. The leap from old to new in production, in design, in government. The willingness to force up the rough (as in rockets) rather than to wait for the sophisticated. The constant pressure on technological production and development, contrasted with pressure to retain the old in the arts and in luxuries. And Mr K's constant refrain: "We've got it, or we'll have it soon!"

With this approach, there is little question which nation will first have a man in space. We will insist upon adequate safeguards, a 90-10 chance that the astronaut will get back. Not so in the USSR. Given the workable vehicle, Russia will again take the calculated risk as she did on passenger jets and missiles—she'll send up the manned satellite. If the "volunteer" astronaut stays up there as the dog did, he volunteered, didn't he? Something must be paid for progress, and what is one man's life—with the stars waiting to be won?

Come to think of it, what is one man's life? We kill men by the hundreds in automobiles, with less risk and less to gain. So we, too, are a paradox—too sentimental to risk one man in space, but willing to risk all our lives in everyday living and possibly in nuclear conflict. Willing to risk our future for present comforts; unwilling to sacrifice a pawn or two for international position in what has always been a deadly chess game. We will thrill over a fixed quiz contestant sweating in an isolation booth, weep over a man who dies trying to save his dog, but cannot coldly look our problems in the eye and plan for strength to resist repeated stresses.

That's why we are failing under the creep and fatigue technique. That's why our mettle shows signs of crack formation.



for maintenance, adjustment, repair,

WHAT SIZE ACCESS OPENINGS?

When designing the package for your equipment, be sure to provide service openings that meet these minimum dimensions. They accommodate the majority of maintenance personnel.

JOSEPH L SEMINARA *human factors specialist, Saratoga, Calif*

Unless you're putting a box around a group of components that are 100% reliable–and very few components are–you've got to provide some way to get at the innards. In some instances a small hole that admits a screwdriver or a grease gun is sufficient. Other times the service man may have to get a hand in or perhaps his whole body. In such a situation, what size opening should be specified?

Measuring your own hand is not recommended–the maintenance man may have a larger hand. And if you arbitrarily add an inch or two to allow for hands larger than your own, the opening may be larger than it needs to be, possibly weakening the structure.

Size of the access openings is determined by a number of factors: the physical characteristics of objects to be removed and replaced through the hole; movements required of the operator (turning, pulling, pushing, etc); size of the body part (arm, leg, head) itself. It is important to emphasize that these anthropometric measurements are not **average** values. Average measurements would permit the opening to accommodate only half the population. The usually accepted design criterion is to fit the machine to at least 95% of potential users.

The data given here meet that requirement. They were gathered from a large group of Air Force personnel (most between 20 and 35 years of age) and do not include allowances for clothing, tools or repair equipment.

Eight recommendations for design of access openings

1 Make access doors easily removable. Quick-opening fasteners are preferred but, in any case, specify as few fasteners as possible—operators will not replace all screws if there seem to be more than necessary.

2 Avoid sharp edges around opening which could injure operator.

3 Hinged access doors should fold back against outer surface to prevent obstruction.

4 Round or oval access openings give greatest usable space per unit area.

5 Wherever possible, place vertical access openings at working height: standing operation, 4 to 5 ft from ground; kneeling operation, 3 to 4 ft from ground; sitting on floor, 2 to 3 ft.

6 Allow extra space (or window) for tasks that require the operator to see what he is doing.

7 Provide illumination where interior cannot be lit by natural light or service lamp.

8 Where opening leads to high voltage or other potential hazards, provide safety interlocks and attention-getting labels with instructions to maintenance man.

EDITOR'S NOTE: Additional human engineering data that help the designer match machine to operator for best efficiency will be found in:

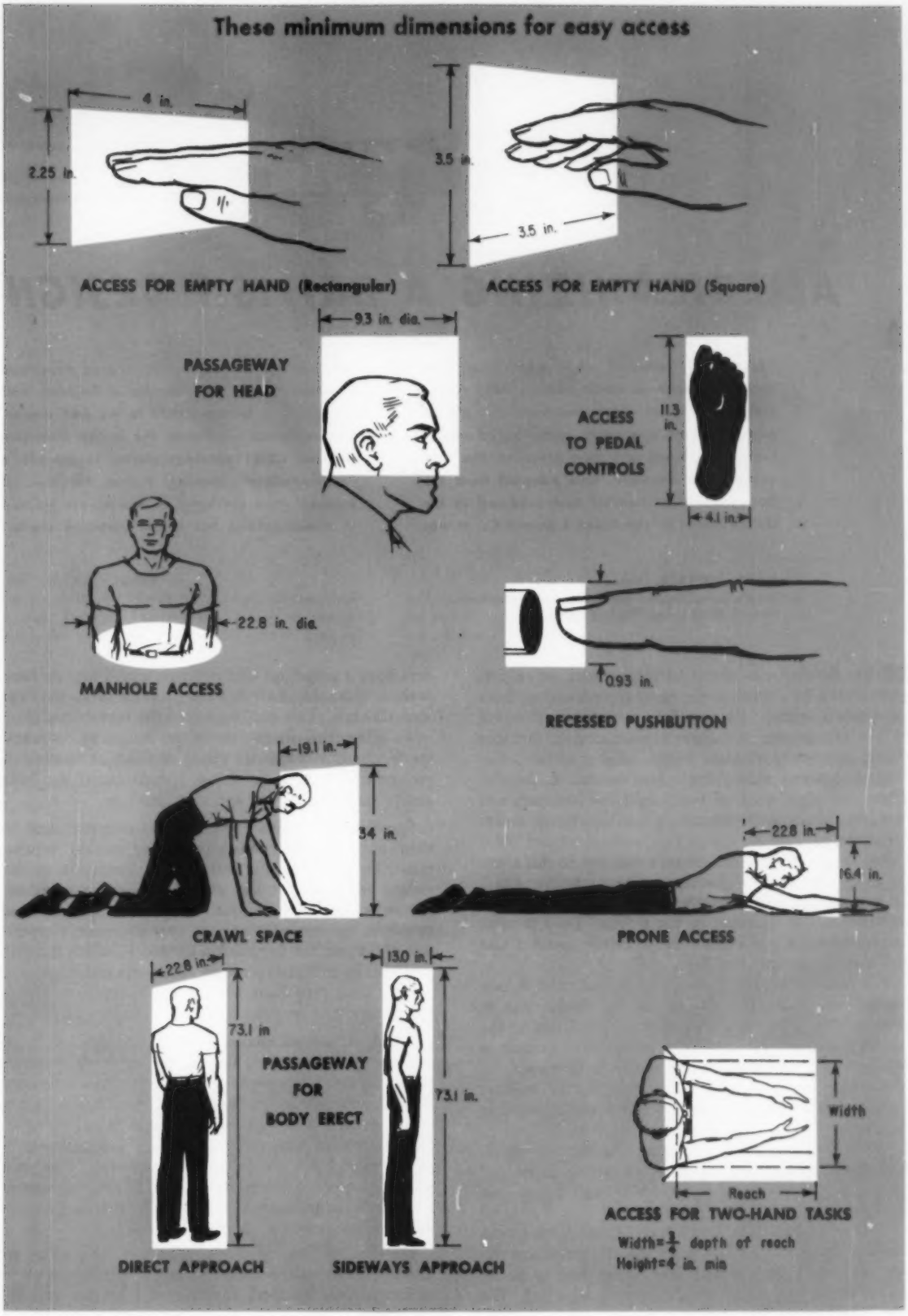
Readable Panel Markings, May 25 '59, p 55. Three criteria help labels and identifying tags perform their job with maximum efficiency.

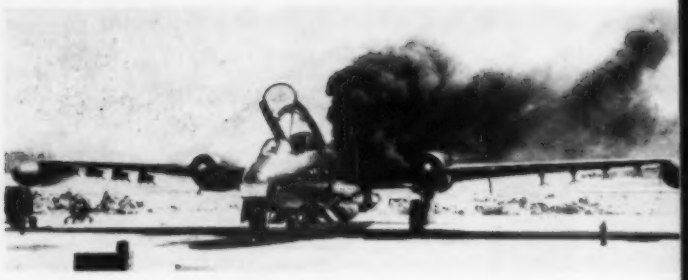
Choosing Selector-switch Knobs, Dec 8, '58, p 103. A functional shape for knobs that makes them readable and easy to position.

Nine Ways to Make Instruments Readable, Feb 3 '58, p 61. How to avoid trouble-makers (poor illumination, illegible numerals, confusing scales).

Designing Control Consoles, Apr 13 '59, p 64. Dimensions and recommendations for efficient layout of controls and instruments.

Designing Products to Suit Human Dimensions, Sept '55, p 64. Anthropometric measurements assure that the machine fits its operator.


These minimum dimensions for easy access
4 in.
2.25 in.
ACCESS FOR EMPTY HAND (Rectangular)
3.5 in.
3.5 in.
ACCESS FOR EMPTY HAND (Square)
PASSAGEWAY FOR HEAD
9.3 in. dia.
ACCESS TO PEDAL CONTROLS
11.3 in.
4.1 in.
22.8 in. dia.
MANHOLE ACCESS
0.93 in.
RECESSED PUSHBUTTON
19.1 in.
34 in.
CRAWL SPACE
22.8 in.
16.4 in.
PRONE ACCESS
22.8 in.
73.1 in
PASSAGEWAY FOR BODY ERECT
13.0 in.
73.1 in.
DIRECT APPROACH
SIDEWAYS APPROACH
Width
Reach
ACCESS FOR TWO-HAND TASKS
Width=3/4 depth of reach
Height=4 in. min



AMERICANIZING A BRITISH DESIGN

Exchange of technical information among the nations of the Free World presents more than a language barrier—disparities are met in dimensional systems, tolerances, materials, manufacturing techniques and shop practices. The B-57 bomber, for example, was adapted from the British Canberra bomber and produced in the United States by the Glenn L Martin Co. It was powered by the Sapphire jet engine developed by the Armstrong-Siddeley Co of England, and converted by Curtiss-Wright to the J-65 engine. General Electric adapted the British Thomson-Houston QT-21 cartridge starter to provide a "self-contained" starting system for the jet engines. Here are some of the lessons learned in Americanizing the British cartridge starter.

F. W. FERNALD, *manager*
Manufacturing Engineering, Ordnance Department
General Electric Co., Pittsfield, Mass.

Before development of the cartridge starter, jet engines were started by electric power or by compressed air from an external source. To provide a self-contained source of starting power, the British developed a cartridge starter using exhaust gases from a solid-propellant cartridge to power a small turbine that started the engine. These cartridges were relatively light and compact and could be carried in the aircraft as a self-contained means for starting.

But the cartridge-starter concept was new to this country at the time the B-57 bomber was being Americanized. To save the cost of a complete development effort, design information was furnished by the British. Their product had completed a qualification test to British specifications and three prototypes had been produced.

We found the British design ingenious, and it performed very well. But the mechanical design was in keeping with the facility and manpower available to the British company, and required a considerable amount of fitting during assembly. It had not been developed for production in quantity. In addition, British military specifications in general were less severe and demanding than ours.

We felt we could get lower cost and better performance by holding closer tolerances on fitting parts, and tooling up to minimize hand fitting and adjustment during assembly.

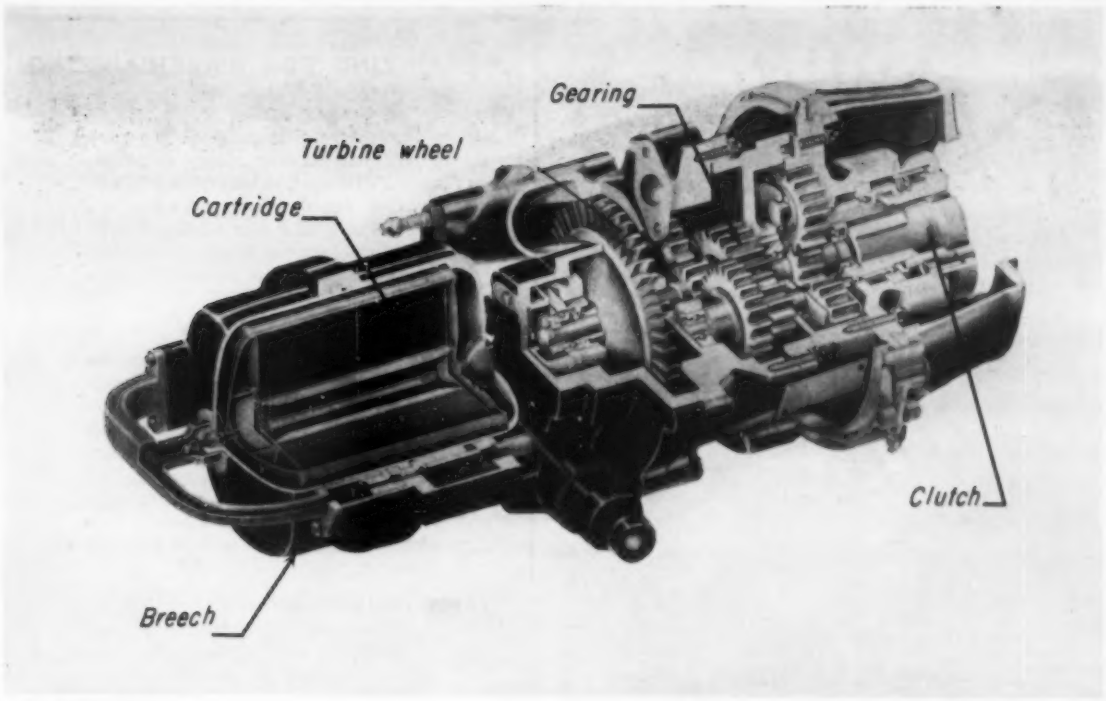
The British breech to hold the propellant cartridge was developed primarily for laboratory use. Its propellant was cast into the breech which, after firing, had to be returned to the propellant manufacturer for reloading. We developed a propellant that could be loaded into an inexpensive disposable cartridge case, similar to an over-size shotgun shell. This case went into the breech easily.

To adapt this British prototype design to American specifications and manufacturing methods, a number of problems were faced in service specifications, standards and tolerance, materials, and shop practices.

Specifications. British specifications were patterned to their own climatic conditions and to tactical requirements for defending the British Isles. American specifications required that the starter be operable anywhere in the world. For example, the British specifications called for the starter to operate at a minimum temperature of 0 F; we had to go as low as −65 F, which brought problems in critical dimensions, tolerances and lubricants. Also, a solid propellant had to be developed to give a satisfactory start over the entire temperature range.

Standard and tolerances. British drawings had basic dimensions in the metric system, bearing bores in inches—and employed first angle projection. On our drawings, basic dimensions are in the inch system, bearing bores in the metric system—and we employ third angle projection. Bore sizes were converted by analyzing each bearing and selecting the nearest metric equivalent. American splines varied considerably from British standards. Changes were necessary in threads. The British drawings were not too definitive in specifying finish.

Materials. These problems were met by finding an available American material having properties equal to or better than specified, supplemented by our own ex-



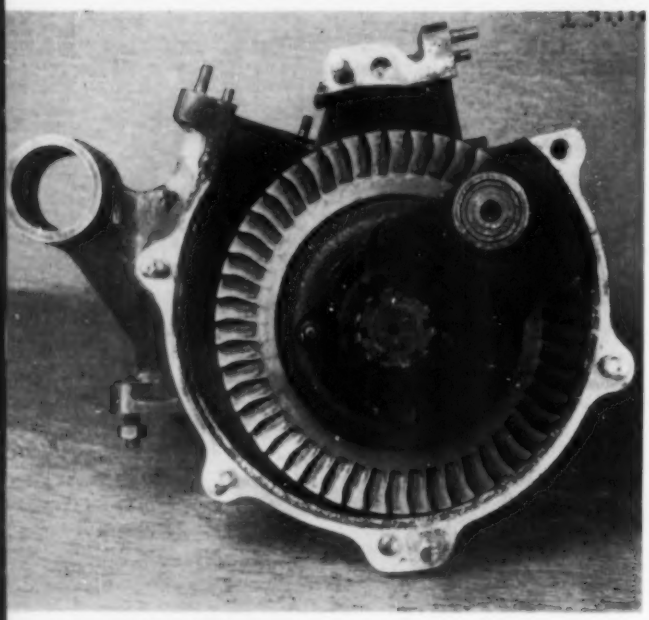
Jet engine starter . . .
for the Martin B-57 bomber is a small, self-contained turbine. Hot gas from the solid-propellant charge drives the turbines at 50,000 rpm—geared down to 2000 rpm at the clutch. Developed by the British, this starter was redesigned for production to American standards.

perience with turbo-superchargers and jet engines where parts were exposed to exhaust gases from the cartridge. Finally, a stress analysis was made of all parts, followed by changes to meet American specifications.

Shop practices. The British drawings were made to be used by skilled manpower in small-lot production both for machining and testing. Tolerances were wide or indefinite—based on making adjustments at assembly and test. We tightened tolerances and designed tools and gages, to place minimum reliance on operator skill.

For the turbine wheel, for example, the British design called for a stainless steel wheel blank with milled turbine buckets. We had developed a castable material with necessary strength at high temperatures which we substituted for the buckets, and these cast buckets were then welded to the stainless steel wheel. At a joint in the turbine casing holding low-pressure exhaust gases, the British milled a concave surface that was not practical to

Propellant charge . . .
in British design was cast into unit (left) that had to be refilled at the factory. American redesign (center) supplied disposable cartridge that's easily inserted (right) in breech.



Turbine buckets . . .
in British design were milled out of a solid stainless blank; Americanized design shown at top used cast buckets welded to the wheel. Corrosive effect of an earlier propellant charge is evident in the view, below, from the gear-case side. A new propellant was developed to reduce corrosion.

produce in quantity, so we modified the design to a flat milled surface.

This example demonstrates some of the problems faced in the exchange of technical data between countries with design traditions and production heritages that differ. Five basic steps in Americanizing a product are listed above, indicating the major problems involved. In addition, all detailed drawings must be checked by the project teams for loads and stresses, adaptability to our machine tools and production methods. And conversion of foreign drawings to American standards must be made without loss of experience gained in the original design.

ORGANIZING FOR AMERICANIZING

1. Set up a project team

Place one man in charge of the entire project from the start through to production. Determine whether problems will be primarily design or manufacturing, and then select a man with similar strength. Give him competent people to start the project, and let him expand his team as the work progresses.

2. Get technical background

The project-team members must become thoroughly familiar with the prototype design and the American end-use—through visits with the prototype designers and detail study of the design, manufacturing, and testing techniques. Find out how the product will be used and what is expected of it. Have samples of complete units and critical parts of prototype for study.

3. Put prototypes to work

Produce a small lot of prototype units to prove out new manufacturing techniques, design modifications, and new materials. Use these prototype units to run qualification tests to American specifications. Incorporate design improvements based on prototype results.

4. Start training early

Begin to train shop personnel early in the program, particularly in assembly, inspection and test. Have key people from these areas work with the project team during acclimation. Have project team follow early units through assembly and test.

5. Consult the original manufacturer

During the developmental and qualification testing, maintain close liaison with the original manufacturer. You will find that much of the experience of the original designers cannot be passed along in writing or through drawings.

EDITOR'S NOTE: This example is but a special case for the common problem of "how much tooling" faced in every new product. See "Design for Automatic Production," June 23, '58, p 81 for three outstanding case histories: for automotive components in high production, for precise manufacture of an instrument device in moderate volume, and for a low volume, heavy and complex electric motor. Motive behind each case was to free production and assembly operations from limitations of human muscle, dexterity and skill and thus add greater value—more performance for less cost.

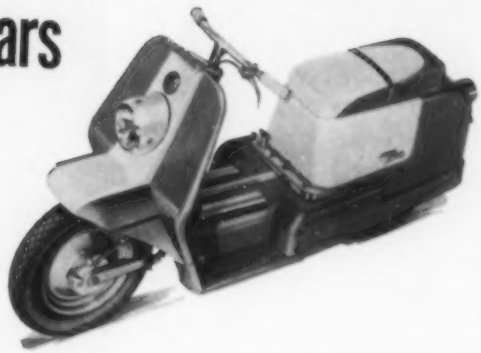
For a step-by-step approach to keep debugging time and cost within reason, see "Debugging—That last Step in Design," Sept 15, '58, p 92.

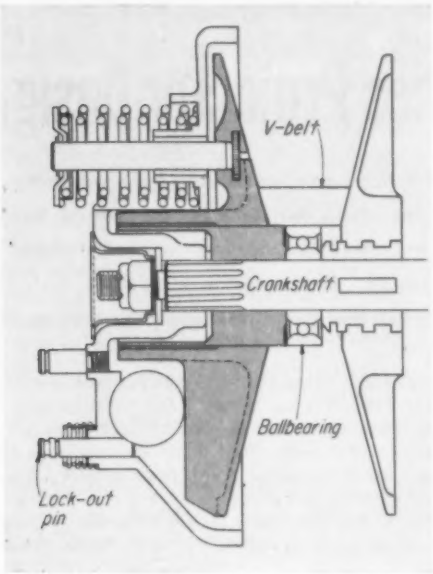
DESIGN FEATURES IN NEW PRODUCTS

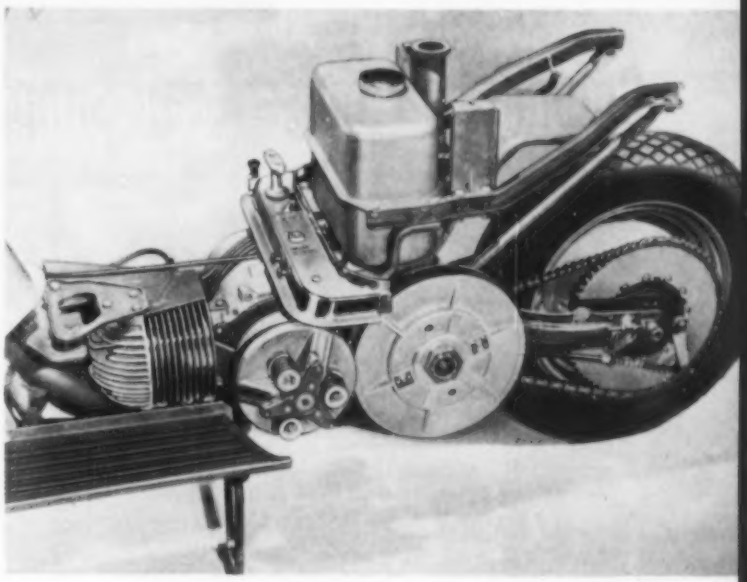
Smoother Drive Without Gears

The transmission in this motor scooter is torque-sensitive; motor speed controls continuously variable drive ratio. Operator merely works throttle and brake.

Scooter is powered by a 2-cycle, single-cylinder engine of 10-cu-in. displacement. The 1.7-gal. fuel tank gives a cruising range up to 170 miles. Fully automatic transmission eliminates manual clutch and shifting, provides smooth acceleration. "Topper" is produced by Harley-Davidson Motor Co, Milwaukee.



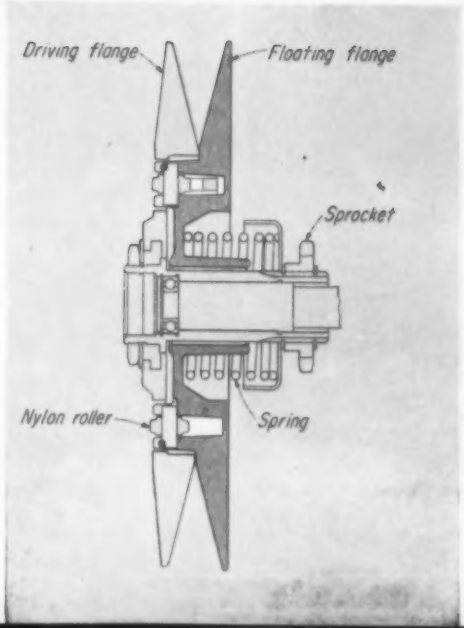


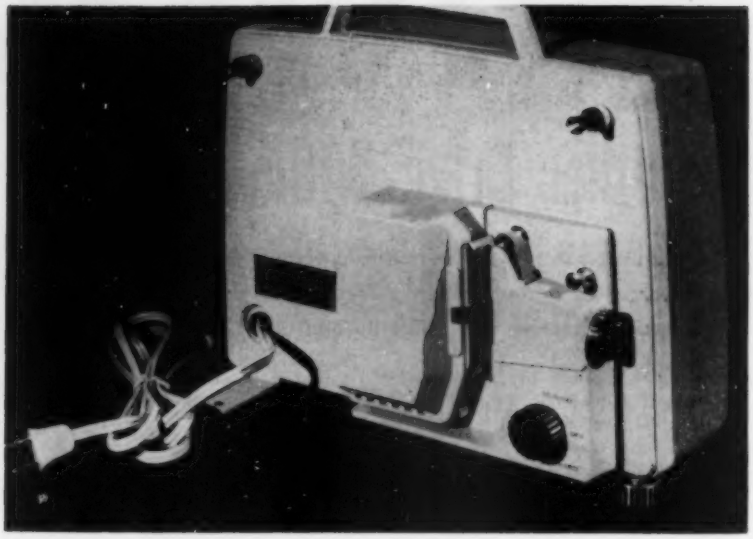


Variable-diameter V-belt pulleys . . . connect motor and chain drive sprocket to give a wide range of speed reduction. The front pulley incorporates a 3-ball centrifugal clutch which forces the flanges together when the engine speeds up. At idle speed the belt rides on ballbearing between retracted flanges of the pulley. During starting and warmup a lockout prevents the forward clutch from operating.

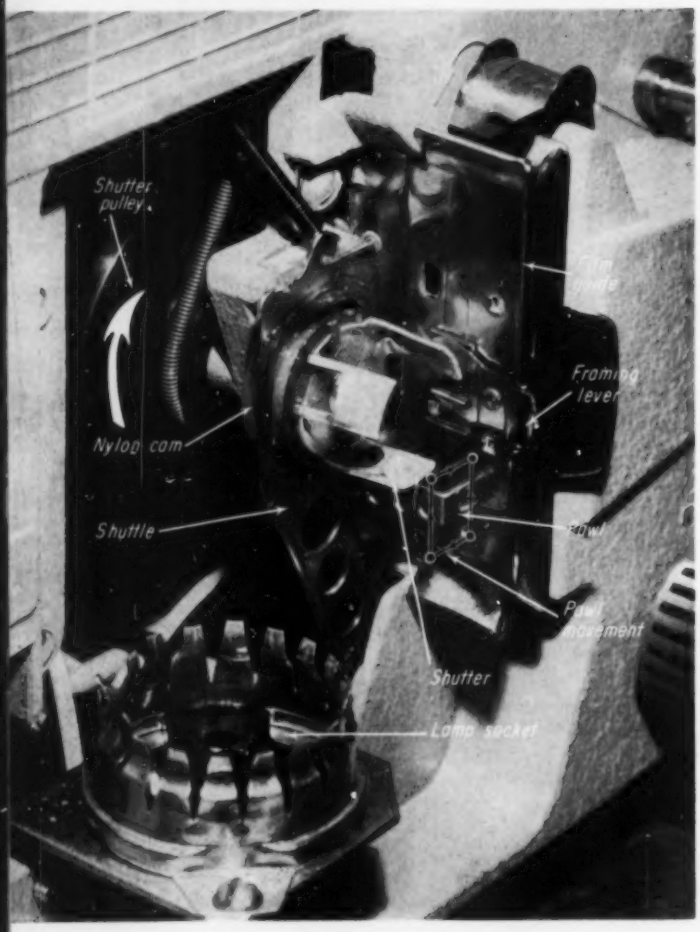
Upon initial engagement the over-all drive ratio is approximately 18:1. As engine speed increases, belt rides higher up on the forward-pulley flanges until over-all drive ratio becomes approximately 6:1. Resulting variations in belt tension are absorbed by the spring-loaded flanges of the rear pulley. When clutch is in idle position, the V-belt is forced to the outer edge of the rear pulley by spring force. When the clutch engages, the floating half of the front pulley moves inward increasing its effective diameter and pulling the belt down between flanges of the rear pulley.

The transmission is torque-responsive. A sudden engine acceleration increases effective diameter of the rear pulley, lowering the drive ratio. It works this way. Increase in belt tension rotates the floating flange ahead in relation to the driving flange. The belt now slips slightly on its driver. It's at this time that nylon rollers on the floating flange engage cams on the driving flange, pulling the flanges together and increasing effective diameter of the pulley.





Complex Casting—But Simplifies Projector Design

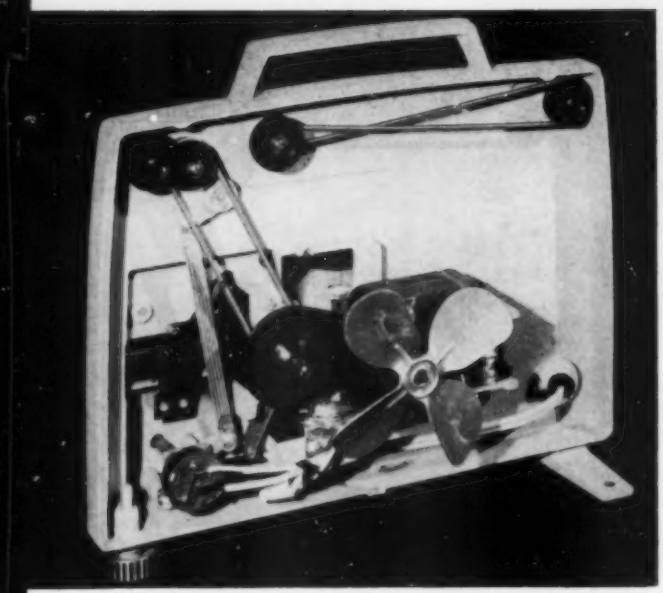


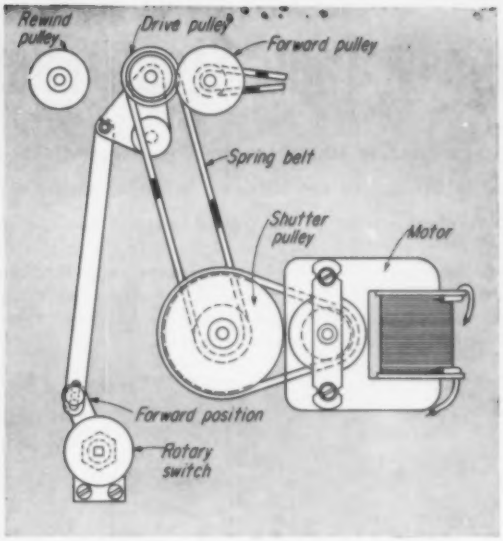
Diecastings and stampings ease assembly of this home movie projector. Single knob control combines electrical and mechanical switching. Shuttle drive eliminates sprocket and gears for easier threading.

The all-metal projector has built-in carrying case, measures 10¾ x 5⅝ x 8½ in., weighs 9 lb. Projection bulb is 150-w reflector type that throws 46 ft-candles on a 3 x 4-ft screen 20 ft away. Total power consumption is 200 w. Lens mount has helical thread, bearing against a leaf spring, allowing lens to be pulled out for cleaning or rotated for fine adjustment. Baskon Automatic 500, 8mm projector is produced by Baskon Corp, Santa Monica, Calif.

Shuttle mechanism . . .

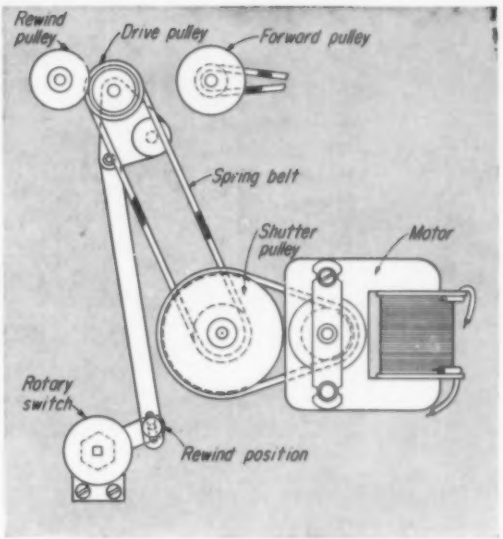
drives film, eliminating need for sprockets and gears. Motor connects to the shutter pulley by an O-ring drive belt. Shutter pulley spins the light-chopper—a triple shutter that interrupts the light path so that the eye is not distracted as the film moves. Nylon cam on the shutter-drive shaft moves the shuttle in the intermittent path required to insert the pawl fingers in the film, move it one frame, and withdraw the fingers. A leaf spring on the bottom of the shuttle arm and a coil spring connected to its upper edge keep shuttle in contact with cam. A framing lever is incorporated with the film guide to provide for variations in relationship of perforation to frame.

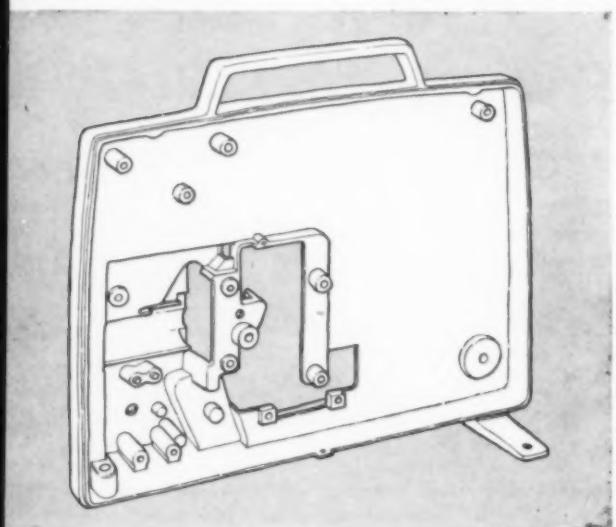




Reel drive . . .

for both forward movement and rewind is shifted by the rotary switch; it also controls lamp and drive motor. A short lever on the switch shaft is linked to an over-center mechanism on which the drive wheel is mounted. During the shift from forward to rewind, the drive pulley crosses its pivot point so that spring tension of the drive belt maintains pressure on the driven wheel. Drive from shutter pulley is 1:1 by spring belt to drive pulley and through a reduction when the forward pulley is engaged. When rewind is engaged, the reduction is eliminated and film rewinds at several times forward speed.





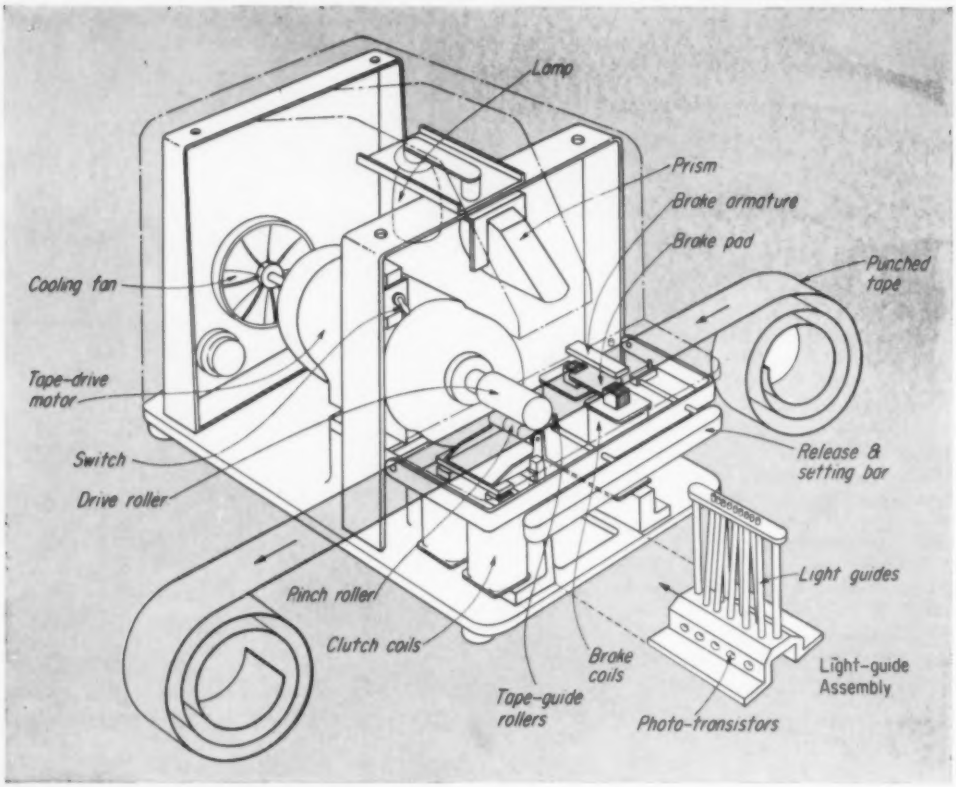
A single diecasting . . .

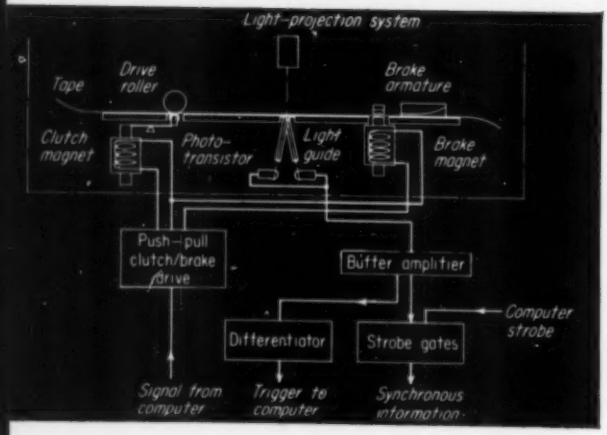
is the backbone to which all working parts are attached—even includes the projector's carrying handle and feet. The casting is zinc-based; on operator's side of projector it uses a ribbed-surface pattern for decoration and raised lettering for switch positions. Stamped covers engage a lip on upper edge of the casting, are retained by a simple latch at the base. Completing the assembly is a removable, die-cast lamp housing that encloses the projection lamp and provides a light-tight cooling shroud.

Speedy Tape Stops Fast Too

Though it handles 1000 characters per second this tape reader is braked to standstill within one punched hole. The brake generates its own high voltage for speedup action.

The machine handles 5-, 6-, 7- or 8-hole punched tape for highspeed computer operations. Phototransistors are connected to buffer amplifier for information or program feeding. The unit is manufactured by Associated Automation Ltd, subsidiary of Elliott-Automation, London, Eng.





Pair of rollers . . .

provides rapid acceleration and deceleration of tape. Upper roller is mounted directly on the motor shaft. Lower (pinch) roller is mounted on pivoted armature and acts as a clutch when its electromagnet is activated.

Stopping within one punched hole is achieved by electromagnetic brake which clamps tape to brake pad. Brake is overriding control since clutch force is only ⅓ of brake force. Speed of brake operation (necessary to avoid losing characters on restart) is accomplished by using small armature displacement and high voltage generated in the inductance to produce a high potential across it. Coil is energized at 5 volts but has 1600 volts' measured potential. Push-pull circuit powers brake and releases roller with single signal.

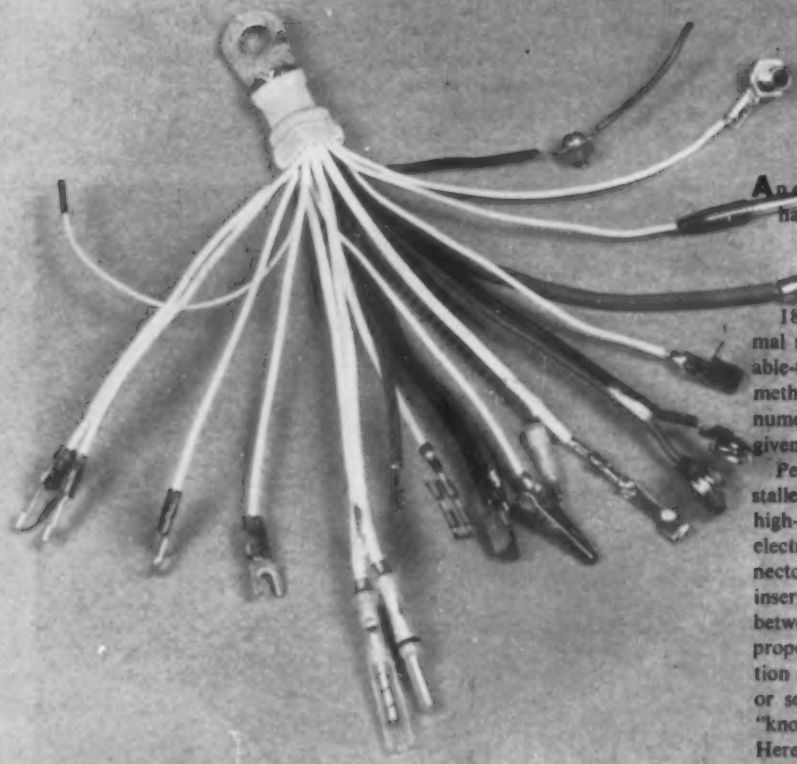
Clear plastic guides provide accurate pickup and transmission of light from the punched hole in tape to light-sensitive transistors. Light is directed to tape surface by hooded prism projecting from front of reader housing. Release bar retracts the guide rollers and disconnects both magnetic coils for setup or positioning of tape.

A PRODUCT ENGINEERING SPECIAL REPORT

how to choose the right

ELECTRICAL CONNECTION

Here for the first time are direct comparisons among all electrical connection methods – permanent and separable. To give you this report, the author compiled and analyzed important test and field data from all known sources, including AMP's outstanding Laboratories.

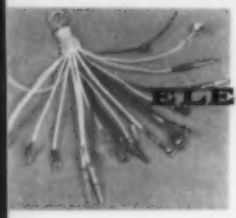


JAMES H WHITLEY,
research scientist
AMP Inc, Harrisburg, Penna

An electrical connection is more than a piece of hardware – it is a technique. And it will work only when the connector matches the application. Just for permanent-type connections alone, there are 18 different mechanical, chemical and thermal methods of joining conductors. For separable-type connections the possible variations in methods, base materials and platings are so numerous that only the fundamentals can be given – no table is large enough.

Permanent connections are meant to be installed and left alone, and can be made with a high-pressure or solid-metal joint that is stable electrically and mechanically. Separable connectors are designed for occasional or frequent insertion-removals, and a compromise is made between electrical performance and mechanical properties such as strength, separability, friction and wear. But for either type – permanent or separable – the engineer starts with five "knowns" and must pick a connector to match. Here are the knowns:

• Operating voltage and current • Mechanical strength needed • Wires and components used • Service and environment • Space available.



ELECTRICAL CONNECTION (CONTINUED)

PERMANENT

A simple selection table of performance, applicability and cost, page 74, is possible for permanent connections because each joint is fixed. Contact wear, a problem in separable connections, doesn't exist for permanent connections.

In the table, a rating value from zero to 10 is assigned to each connector type for each performance category. A "10" value means that the connection method (top of table) is very suitable in the category considered (left side of table). Lower values are proportionately less satisfactory, but even values as low as "5" are acceptable. A value of "0" implies that the connection method, although applicable, is a very poor choice. A "dash" means it is not applicable.

For example, a twisted-wire terminal has a "10" rating under each of three cost categories, meaning it is very economical. But it rates "1" for "Applicability to Aluminum Wire" (troublesome oxides form quickly) and should not be used in that application.

A 100% consistency in ratings is impossible, however, because a given connection method may vary widely in workmanship. A low-rated connection, expertly made, will work better than a high-rated one, poorly constructed. For convenience in using the table, it is assumed that all connections are equally well made in ordinary production facilities by a good manufacturer.

Start with Application Requirements

Only horizontal comparisons should be made in the table. That is, select the desired performance category (left column) and compare available types of connections for that category only. But do not make vertical comparisons. That is, do not select a connection method, then attempt to pick acceptable performance categories . . . the rating values are based on standards that differ too widely. However, approximate comparisons can be made.

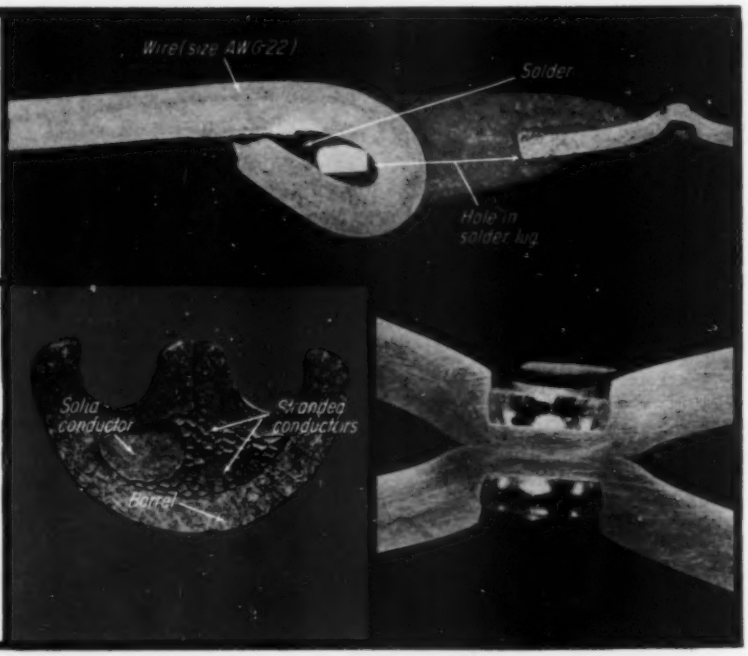
ELECTRICAL PROPERTIES

Low electrical resistance—the first performance category in the table—is the primary reason for a connection.

Soldered-wire connection . . . shown in cutaway is made with simple equipment, but manual skill is important . . . . . method cannot be readily made automatic. Over-all electrical resistance is low, but current flow through the solder — a poor conductor — will concentrate in areas where solder is thin, creating local heating.

Crimped connection . . . can be made with unskilled labor — but skill must be built into the tool. Exact mechanical control is essential to get right amount of deformation, avoid damage. Method can be automatic.

Cold-welded . . . aluminum plates in cutaway (each 1½ x 1½ x ¼ in.) were joined with pressure only, at room temperature. Note intimate contact, with no interface line.



CONNECTIONS

Connections using size AWG 22 wire and larger should not exceed 1 milliohm resistance. Several milliohms is tolerable if value is stable. One ohm is too high. A rule of thumb is that the total resistance of a connection should be equal to or less than an equivalent length of wire used in the connection. A size AWG 16 copper-wire connection (about 1 in. long) should have a resistance equal to or less than that for a 1-in. length of AWG 16 wire, about 0.34 milliohms. Unavoidable resistance at the contact surfaces can be compensated for by a larger current-carrying cross-section in the connector.

Resistance stability is essential. Low initial resistance, although necessary, is not a reliable criterion for a good connection. It is far more important (and more difficult) to get a resistance value that will remain both low and stable throughout the life of the equipment. Those connection methods that produce a solid metal bond are best. Twisted wires and unsoldered eyelets are unsatisfactory, even though they allow initially low values of resistance. When eyelets are part of plastic or fiber circuit boards, the dimensional instability of the boards can vary contact force of the electrical connections. Ratings of stability in the table are for connections operating in normal room environments.

Low-voltage (dry) circuits require exceptionally clean connections. There must not be oxides or contaminating films that the available voltage cannot break through. Although no particular value of voltage can be declared "dry," it is agreed that above 10 v, oxides and films are readily broken down; below 1 v the connection might behave as an open circuit. High-pressure connections and solid-metal interfaces will usually prevent formation of oxides and films. Interface contact pressures up to 20,000 psi are sometimes necessary, but 2000 psi is generally enough. Crimp connections are formed under initial pressures exceeding 30,000 psi, deforming the metal and scrubbing the contact surfaces. The residual pressures remaining are about 1000 psi.

High currents need large conducting areas. Conversely, if a large current is funneled into a small cross-section, excessive local heating will result. Low measured over-all resistance of a complete connection is not the whole answer. If solder is used, it must have wide contact area but small thickness because solder has about 10 times the resistance of copper. Chemical connections are limited to low and moderate currents because of practical difficulty in obtaining large cross-sections to compensate for the relatively high resistance of the materials. And thermal runaway may occur if connection gets too warm. Wirewrap is limited somewhat because the first few turns carry most of the current.

MECHANICAL PROPERTIES

Pulloff force and over-all mechanical strength of a permanent connection should be as great as that for the members, such as wires and studs, that it connects. It must withstand not only normal pulloff forces, but also some mishandling and abuse. Methods that produce good electrical properties (such as low and stable resistance) usually have good mechanical stability too. A crimped joint with size AWG 16 wire will have as much as 95% of the tensile strength of the wire. But the converse is not true—that good mechanical joints will be good electrically too. A machine-screw joint, if loose, will be a poor electrical connection though strong enough mechanically.

Pulloff force for wirewrap is high if applied in the wrapping direction . . . but the wire will peel off the post if pulled in the unwrapping direction. Welded joints are rated high in the table—but it is assumed that no embrittlement has occurred. Deposited metals have thin sections with low strength. Adhesives are also weak, particularly when pulled in peeling direction.

Creep (stress relaxation) is important mainly in how it affects contact points. Connections that depend on residual stress for maintaining contact pressures (crimping, wirewrap, eyelets, twisted wires) are damaged by excessive creep. Plating and adhesives will crack or pull loose if the base metal creeps and changes dimension. A screw terminal will loosen if the copper wire it presses against relaxes because of creep.

METHODS COMPATIBLE WITH CONDUCTORS

Not all wire types work for all connection methods. Solid wire is the most generally suitable conductor. But stranded wire is unsuited to many connection methods—welding and wirewrap in particular. In wirewrap, the strands will not stay tight; in welding, the strands must be fastened individually. Soldering the strands together makes them solid, easier to place under a screw, but the solder tends to flow under screw pressure, loosening the joint as it ages.

Insulated wire rates high in most methods but usually must be stripped before application. Also, heat from thermal joining methods can damage the unstripped insulation. In crimping, a relatively small amount of strip-

THE 18 WAYS FOR MAKING PERMANENT

PERFORMANCE AND COMPATIBILITY		THERMAL				CHEMICAL			MECHANICAL	
CODE: 10=most applicable, 5=acceptable, 0=not recommended, —=not applicable		Solder	Braze	Weld: Gas or Arc	Weld: Spot	Plating	Conductive Adhesive	Amalgam	Crimp	Wire-Wrap
ELECTRICAL PROPERTIES	Low Resistance	9	10	10	10	8	3	8	9	9
	Resistance Stability	10	10	10	10	8	7	9	9	9
	Low Voltage	9	10	10	10	8	5	8	9	9
	High Currents	8	10	10	9	1	1	3	9	8
MECHANICAL PROPERTIES	Pulloff Force	9	10	10	10	1	1	8	9	8
	Low Creep	9	10	10	10	5	5	9	9	7
	Strength	9	10	10	7	3	4	4	9	7
APPLICABILITY TO THESE CONDUCTORS	Solid Wire	10	10	10	10	10	10	8	10	10
	Stranded Wire	9	9	8	0	10	9	9	10	0
	Insulated Wire	6	2	2	8	9	9	9	10	9
	Aluminum Wire	5	2	1	0	2	2	0	8	1
	Tinsel Wire	5	0	1	1	5	5	5	8	0
	Bus Bars and Structures	8	8	8	9	6	6	6	7	—
JOINING WIRE TO:	Wire	10	10	9	8	—	8	8	9	—
	Component	10	8	5	9	4	5	5	8	8
	Separable Connector	9	8	1	8	5	4	6	9	7
WITH INSULATED CONNECTIONS	Pre-Insulation	0	0	0	1	1	8	9	10	0
	Post-Insulation	8	8	8	8	8	8	10	10	7
RESISTANCE TO ENVIRONMENTS	Hi-Temp	5	9	10	10	6	1	3	9	8
	Low-Temp	9	10	10	10	9	5	8	9	8
	Thermal Shock	8	9	10	10	7	7	7	8	7
	Vibration	6	7	10	9	2	1	7	9	3
	Salty and Humid Air	9	10	10	10	5	5	8	9	6
	Aging	9	10	10	10	8	5	8	8	8
	Hermetic	10	10	10	1	9	9	10	10	1
	Nuclear Radiation	9	10	10	10	9	1	5	9	9
COST ECONOMY	Tooling	7	4	3	4	5	9	7	8	7
	Connector	9	8	8	9	5	8	5	9	9
	Process	6	5	5	5	4	8	8	9	8
ACCESSIBILITY IN ASSEMBLY	Method Needs Little Space	8	5	4	8	5	8	8	9	8
	Ease of Repair	8	6	5	9	7	9	7	9	7

MECHANICAL								
etal wder	Cold Weld	Ultra-sonic Weld	Rivets	Eyelets	Screws		Twisted Wires	Wire Nuts
					Wire	Terminal		
10	10	10	9	8	9	9	9	9
10	10	10	9	5	7	9	5	8
10	10	10	10	5	8	9	5	8
9	10	10	9	5	9	9	8	9
9	10	9	9	7	3	10	2	8
9	10	10	9	8	3	8	2	8
9	10	9	10	9	5	9	4	8
9	10	10	5	5	10	—	9	10
9	1	1	2	5	2	—	9	10
9	9	9	9	9	9	—	9	9
5	8	8	4	4	4	—	1	6
5	0	5	6	6	4	—	0	0
—	8	8	10	10	—	10	—	—
9	9	7	3	3	4	—	10	10
7	7	7	8	8	10	10	10	10
3	3	6	8	8	10	10	—	—
7	4	5	1	5	10	10	0	10
10	7	8	8	8	8	7	9	10
9	9	9	4	3	7	8	5	7
9	9	9	5	5	8	8	7	7
8	9	9	4	3	2	8	2	8
8	9	9	5	5	2	9	1	7
9	10	10	8	7	7	9	4	8
9	10	10	8	7	7	8	7	8
9	10	10	8	1	1	—	1	1
9	10	10	9	9	9	9	9	9
2	4	1	7	8	9	10	10	10
7	8	7	9	9	10	9	10	9
5	5	1	8	8	10	10	10	10
7	7	7	8	9	9	9	10	8
6	6	6	7	7	10	10	10	9

ping is needed—or none, if an insulation-piercing design is chosen.

Aluminum wire has a surface oxide that is difficult to penetrate, whether by thermal, chemical or mechanical means. Some crimp methods will work; cold welding is suitable for solid wires. Wire nuts will break through the oxide film and give a fairly reliable connection and good convenience. Solders have been developed, but are corrosive. Rivets, eyelets and twisted wire do not successfully penetrate the oxide film, and relaxation of the wire reduces available contact force. Amalgams are not compatible with aluminum.

Tinsel wire—thin strands of conductors twisted together with supporting threads—is difficult to terminate by any method. Crimping will do a fair job because it penetrates both wire and insulation, borrowing strength from both. There is too little material in tinsel wire for ordinary welding or brazing, but work is being done on possible ultrasonic, spot, and controlled-arc welding. Twisting and wire-wrap are completely unsuitable.

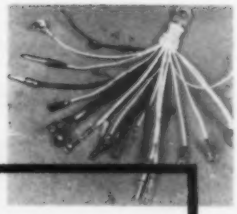
Bus bars and other heavy conductors are best assembled with rivets, eyelets, screws or welds. It is also possible to crimp a sleeve around a bus bar. Ultrasonic welding is a good method for attaching a thin conductor to a heavy bus bar or frame. Two thin plates can be crimped together—in a manner similar to the rolled edge of a tin can.

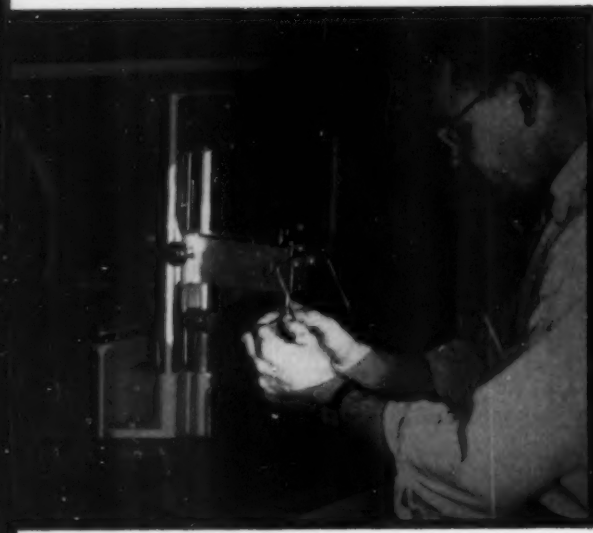
JOINING TWO CONDUCTOR TYPES

A connection method can be perfectly acceptable for a given conductor, yet unsuitable for certain applications using the conductor. For example, gas welding will easily attach a copper wire to any terminal, but if the terminal is intended for a separable connection, the heat distortion might be intolerable. The ratings given are based on over-all feasibility; absence of deleterious effects; space available for assembly.

Wire-to-wire connections made entirely by plating are not recommended, even though plating works for wire-to-component connections. And wire cannot be wirewrapped around another wire, because the binding post must be hard and rectangular for good penetration.

Wire-to-component connections—





Sophisticated equipment . . . such as capacitance-discharge spot welder (left) and ultrasonic welder (right) add to initial tooling cost, but produce excellent electrical connections. This spot welder will connect fine wires and foil materials; the ultrasonic welder will handle metal foils up to 0.03 in. thick.

those on relays, coils, resistors—are given ratings that take into account the fact that such components are sensitive, difficult to handle. Wire-to-separable connections—including some plated terminals on printed-circuit boards, spade terminals, taper pins, and other separable devices—must have good pull strength, stable electrical resistance, and the method must be applicable without excessive heat.

INSULATED CONNECTIONS

Pre-insulation means insulation that is already on the parts being connected, or placed there during the actual connection process. Thermal methods are not recommended for such connections because ordinary insulation might melt, and ceramic insulation will not conduct the heat needed to fuse wires. Crimping is good, because the insulation can be easily pierced, or high-pressure crimping dies can deform both insulation and wire. Binding posts and nuts can be pre-insulated by putting a wide plastic cap over the nut, but this is not common.

Post-insulation is applied after the connection is made. Examples: taping of twisted wires; encapsulation of a terminal board. Symmetry here is important. Therefore an amalgam (can be perfectly round) is rated high; wirewrap (wire comes off from the side) is rated lower.

RESISTANCE TO ENVIRONMENT

Environmental exposure in general tends to:

- Change mechanical properties of materials.
- Change surface conditions of contacts.
- Shift established points of contact.

PERMANENT CONNECTIONS—an example of the selection table at work

Problem:

Wiring harness (pre-assembled portion) for new washer-dryer appliance. High production rate is anticipated; cost and reliability are both important. Given:

- Solid and stranded insulated wires will be used.
- Temperatures will be moderately high; humidity high in some areas. Vibration and high currents will occur in some installations.
- Control circuits must have low and stable resistance.
- Pre-insulated terminations desirable.

Use of Table:

Methods suitable for solid, stranded and insulated wire can be spotted immediately:

Crimp	(10-10-10)
Wire nuts	(10-10- 9)
Deposited metal	(10-10- 9)
Twisted wires	(9- 9- 9)
Compressed metal powder	(9- 9- 9)
Solder	(10- 9- 6)

- A cost comparison on bases of connector and process (tooling is secondary) eliminates deposited metal and compressed powder. Solder rates low in process economy, is also low for vibration and high temperature, and is inapplicable to pre-insulated terminations.
- Twisted-wire method is eliminated because it is unsuitable for vibration, high temperature, and pre-insulation.
- Neither wire nuts nor twisted-wire connections are suitable for terminal connections—they are primarily wire-to-wire methods.
- Crimp method is selected because it is the most generally suitable. Automatic production is possible.
- Alternative is spot welding, but wire must be solid only. Performance will be excellent in all categories, cost will be high. ■

Connection design should provide:

- Large contact forces.
- Low-force-constant (resilient) springs to reduce effects of mechanical changes such as contraction-expansion, creep.
- Protection for contact surfaces. Where necessary, plate with noble metals, enclose in vacuum or inert-gas atmosphere.
- Heat sinks, other cooling means, and careful location of contact surface for good heat dissipation.

Temperature and thermal shock not only break down insulation and speed up oxidation, but cause loosening of screws, rivets and twisted wires because of the cyclic expansion-contraction.

Vibration forces can be surprisingly high, particularly if springs or contact members are in resonance. The high-rated methods generally have either strength or bulk; the low-rated methods lack bulk or strength, have parts that can vibrate and shake loose. Properly applied, twisted-wire connections can help damp vibrations. But soldering the strands may stiffen the connection, increasing likelihood of failure.

Salty and humid air will react with many types of conductive adhesives, causing galvanic corrosion. Such adhesives are cathodic to copper. Wirewrap and other methods that have unprotected points of contact will experience damaging corrosion and are not recommended for adverse atmospheres.

Air-and-water tightness includes ability to withstand the so-called "garden-hose effect" wherein cyclic environmental changes cause the connection to suck in air or water through conduits and other channels. Nuclear radiation—not usually a problem in industrial applications—will damage plastics, probably injure amalgams.

COST ECONOMY

High initial tooling costs for compressed metal powder and ultrasonic welds can be justified only if the special properties of the connections are essential. Connector costs refer to the materials and parts, not to the final application of the connection method. The process—making up the connection—is the key expense for complicated methods. High process costs usually reflect the number of variables to be controlled, indicating questionable production reliability. A low rating is given to a method in the table if a skilled operator must make up the connection . . . soldering is such a method.

ACCESSIBILITY IN ASSEMBLY

Small connections—particularly those that can be applied in cramped quarters—rate high in the accessibility category. Thermal methods rate low because heat may damage adjacent parts and equipment. Also rated low are cold welding, compressed powders, and other methods that need considerable space around the terminal for assembly.

Ease of repair is based on the same general rule as ease of assembly—how much space is needed? Also important: Is restripping of wire allowed? Can connector be repaired in a shop or must repair tools be brought to the equipment? Is maintenance available on regular basis? Is cost per repair important? For a soldered connection, must old solder be completely cleaned off, or is a weakened connection (made by adding some new solder over old) acceptable?

SEPARABLE CONNECTIONS

Only static-type connections are considered. Excluded are dynamic contacts such as relays, commutators and brushes—these, although employing many static principles, are in a special field (see Editor's Note). A simple table such as the one for permanent connections is not possible for separable connections because each type can have hundreds of different combinations of platings, mechanical designs, and conducting materials. Only the principles can be given here.

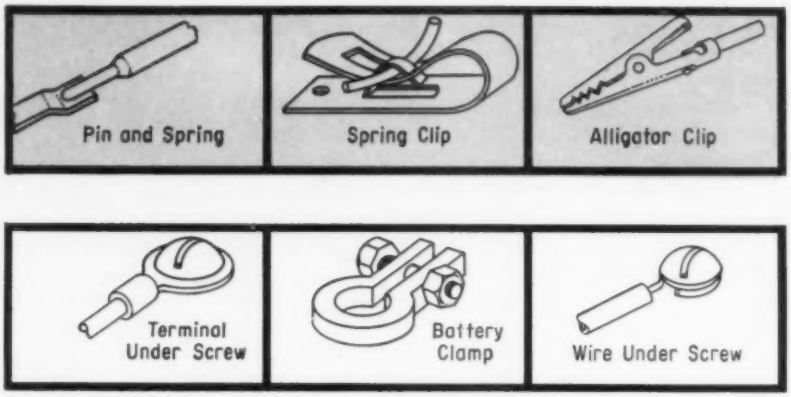
Good over-all properties in separable connections are hard to achieve because of the compromise needed between good contact, ease of removal. The table is a summary of conflicting characteristics.

Electrical contact needs	Ease of insertion needs
High contact force, large contact area	Low contact force, small contact area
Clean, unoxidized surfaces	Well-lubricated surfaces
Contact wipe and metal flow (soft metals)	No wipe, deformation, wear or fatiguing of metal (hard metals)

Nature of the compromise is often obvious. For example, in the familiar home-power plug and receptacle, bare brass contacts and high contact forces are used because wear is no problem and voltages are high enough to break through thin oxide films. Or in the wiring harness for an appliance, ring-tongue terminals with screws and washers provide secure reliable connections that can be disassembled for occasional maintenance.

More often, the compromise is a difficult one. Com-

ELECTRICAL CONNECTION (CONTINUED)



plex circuitry, modular units, low-voltage transistor elements, and multiple connections require competent engineering decisions for good over-all reliability. A representative of the manufacturer should be consulted. The following guide, although no substitute for a specialist, will show areas of trouble, suggest logical choices of separable-connection methods for all general applications.

TYPES OF SEPARABLE CONNECTIONS

Three classes or configurations cover almost all types of separable connections:

- Direct force, spring-applied
- Direct force, screw-applied
- Wedging force

Direct Force, Spring-applied

Pin-and-spring—Suitable for large numbers of insertions-and-withdrawals. Spring force and contact wipe are adjustable. Plating might be necessary if pin and spring are made from copper or copper-alloy materials, because electrical resistance will otherwise be erratic if spring forces are low. The contacts themselves have little mechanical strength, depending on the mounting structure for security. The spring is susceptible to vibration and must be designed to match the application. Exposed contact points are vulnerable to corrosion.

Spring clip—Will attach to almost any shape conductor; widely used for temporary hookups and on dry-cell battery terminals. It makes good electrical contact when carefully applied, and holds well. Not recommended where a large number of operations is planned.

Spring-actuated—Spring does not carry current, and therefore can be designed with elastic materials that will operate for many cycles. The alligator clip shown is a good example, and can have any desired electrical properties in the contact members.

Direct Force, Screw-applied

Terminal-under-screw—The most popular version has a formed copper "spade" or "ring" for good contact and high mechanical strength . . . the spade or ring is generally attached to the wire conductor by crimping. The screw applies high contact forces to the spade or ring—resistance is exceptionally low. Plating is recommended if there is no contact wipe to penetrate oxide film in low-voltage circuits. Wear is seldom a problem.

Clamps—The automobile-battery clamp is an example of direct contact force applied indirectly by a screw. Major advantage is that a large contact area is obtained, not limited by area under screw head. Large currents can be carried. Soft metal surfaces yield to give good contact. Plating may be necessary if oxide films might otherwise prove troublesome.

Wire-under-screw—Solid wire can be clamped under a screw or washer. The screw thread must be tight enough to compensate for relaxation of the wire, yet not cause damage. Not recommended for critical applications.

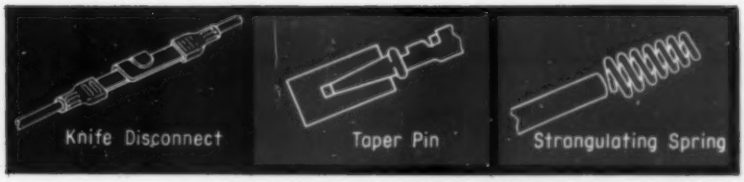
Wedging Force

Wedging forces are in effect sustained by spring action, but the springiness is in the connector structure which is relatively stiff compared with the flexible springs already described.

Knife-and-wedge—High contact forces result from the wedging action that spreads the female member. Heavy wiping cleans contact areas, and electrical resistance remains fairly low even with unplated brass elements. For low-voltage, semipermanent connections, plating is required . . . and performance will be good until wear or fatigue reduce the contact forces.

Taper pin-and-socket—This cylindrical wedge (included angle is 3½°) has very high contact forces, low and stable electrical resistance. Wear rate is high, but has little effect on connection until excessive. Plating on contact surfaces is not necessary, but will reduce oxide-film troubles. Popular applications are in sensitive test instruments.

Strangulating spring—Similar to taper pin-and-socket, but with a more resilient socket. Example is helicon disconnect splice shown in sketch, which has "Chinese-finger" action that grips pin tighter when withdrawal is attempted. Yet removal is easy if pin is twisted slightly in



WEDGING FORCE

unwinding direction. Initial contact forces are lower than for ordinary taper pin, and plated surfaces are more desirable.

Ball-and-detent—Wiping action is good on one contact only. Mechanical strength is good. Drawbacks are that contact force is low in closed position—compared with higher forces occurring during insertion—giving wear rate higher than necessary for contact pressure achieved. Plating is recommended for contact surfaces that don't get good wiping action.

Sliding fit—Slight interference between mating parts gives high contact forces, good wiping action. Plating of contact surfaces is not necessary. Faston-type connection shown in sketch has fairly resilient structure that gives moderate amount of tolerance to the close dimensions needed for the force fit. Less resilience will lead to troubles caused by wear, dimensional inaccuracies, thermal stresses, fatigue, creep and relaxation. The sliding-fit connection is best suited to semipermanent applications.

Force-fit spring-and-socket—It is fundamentally the same as the sliding fit above, but has male instead of female flexible member. Banana plug in sketch is an example. Both types (male or female part flexible) are suitable for precision connections because the interference can be closely controlled within practical limits of dimensional tolerance and mechanical resilience of electrically conducting alloys. Contact wear and metal fatigue are the main problems, especially where high contact forces are needed and space is limited. The withdrawal-insertion forces increase directly with the number of pins in the connector, and can become intolerable.

PERFORMANCE AND COMPATIBILITY

A table is not practical because of the variety of combinations possible, but the basic rules that apply to all separable connectors are:

Electrical Properties

Low resistance—0.001 ohm and less—requires high conductivity material. Mechanical considerations such as springiness must be secondary. Plating is often required.

Higher resistance values of 0.1 ohms or more are easily obtained, even using materials selected for good mechanical and chemical properties such as elastic modulus, corrosion resistance and fatigue strength.

Resistance variations of up to 100% (if the initial value is small) are acceptable and easily obtained in most ordinary separable connections. If variations of 10% or less are considered important to an application, then unusually good connections are required. Be certain that wipe occurs, surfaces are free of oxide film, and contact force is maintained. But if 100 or more insertion-removals are expected, wear becomes a serious problem.

Low-voltage (dry) circuits of 0.001 v and less require low-resistance connections. In some instances, precious-metal plating is worth the extra cost. Above 10 v, no particular precautions are necessary. High currents (over a few amps) demand large conducting areas.

Mechanical Limitations

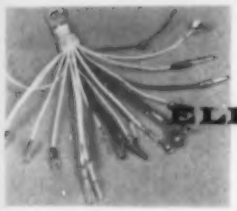
Insertion-removal forces of less than 10 lb can be readily applied by hand, but might also be inadvertently applied by accident. Yet higher forces might call for special tools. It is essential to decide beforehand whether the hand, a screwdriver, wrench, or some special mechanism will open and close the connection.

If mechanical abuse—pulling, bending, vibration—is predicted, allow for this when choosing electrical design features. High contact forces permit mechanical abuse without radically altering electrical resistance. Conversely, delicate, long-wearing connections cannot stand abuse.

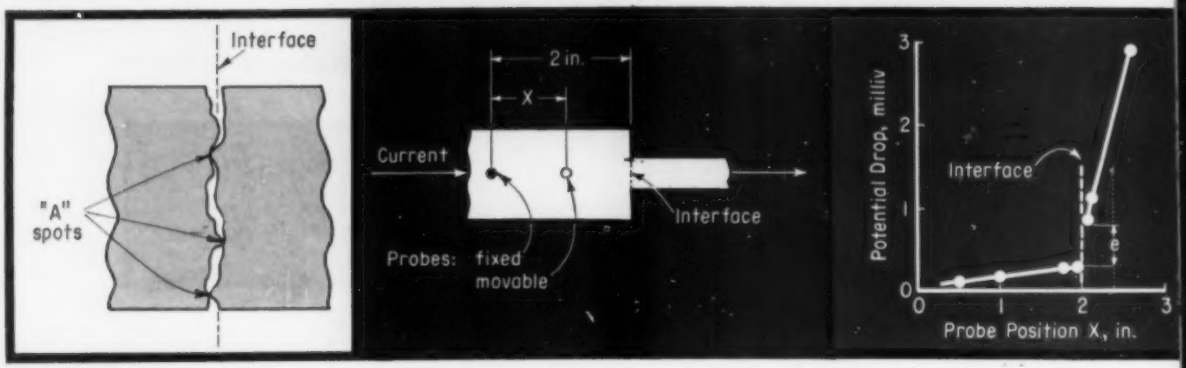
Resistance to environments

Temperatures above 500 F cause diffusion of some metals, and weld contact surfaces. Moderate temperatures as low as 200 F cause rapid oxidation of base metals, but platings of nickel, silver or gold will protect them. Thermal shock damage can be avoided with spring members that are resilient.

Vibration will cause shifting of contact points (see Contact Theory, p 80) unless sufficient contact force—3 lb or more will usually do it—is maintained. Resonance can be avoided by selecting stiff elastic members (high



ELECTRICAL CONNECTION (CONTINUED)



Contact interface . . . conducts current through points of contact called asperities or "a" spots. Constriction of current flow increases resistance.

Constriction resistance . . . at a contact interface is simulated by this stepped brass cylinder that represents one point of asperity—a single "a" spot. Probes measure voltage drop for 20-amp test current. Discontinuity, e, occurs as movable probe passes interface because current flow lines are constricted from 0.685 to 0.125-in. dia.

CONTACT THEORY

■ True areas of contact are thought to occur at minute points —microscopic asperities called "a" spots—distributed over the two surfaces. Their number and distribution is dependent upon the shape and finish of the contact members. But the total area of true contact—usually a small fraction (1/1000) of the apparent contact area—is a function of only the contact load (force).

The "a" spots are under very high unit pressure . . . elastic and plastic deformations flatten the asperities, creating just enough area to support the applied load. Under that condition, the unit pressure is constant, equal to the "flow-pressure" of the materials involved. The true area is related to the applied force and flow pressure as follows:

$$A_{true} = \frac{F_{applied}}{P_{flow}}$$

Electrical resistance in the direction of current flow across an "a" spot will be zero (in theory only) if metal-to-metal contact exists, because the path length is zero. However, that is not the whole story. These two factors combine to give finite effective resistance.

• Constriction resistance. The sketch shows how electrical-current flow lines must converge to pass through the "a" spots. The effective path length (and resistance) of such flow lines is greater than the apparent length (and resistance) of the connector body.

For example, if a size AWG 10 wire (about 0.1 sq in. cross-section) is terminated in a connection with 0.001 sq in. true contact area, constriction resistance at the contact surface will measure about 0.7 milliohm. Yet the resistance of 1 in. of wire is only 0.083 milliohm. A connector 1 in. long, including the wire and termination, will generate over 90% of its total heat loss at the contact surface—an unsuitable condition when currents are high. Solid-metal bonds or high contact forces are needed to increase the true contact area.

• Film resistance. If contact is not metal-to-metal, but has a layer of oxide, oil or contamination, effective resistance will increase. Film often contributes the major electrical resistance in a connector.

Combined effective contact resistance (constriction and film) obeys this equation:

$$R_C = \frac{K \rho \sqrt{P_{flow}}}{(P_{applied})^N} + R_{film}$$

where:

R_C = combined effective resistance, microhm, at contact surfaces
K = a constant, depending on shape and finish of surfaces
ρ = electrical volume resistivity, microhom-in. (1-in. cube). Resistivity of a 1-cm cube is $\rho \times 2.54$.
P_{flow} = contact pressure, psi, that will cause plastic flow (a measure of hardness)
$F_{applied}$ = total applied force, lb, holding contact surfaces together (measured normal to contact surfaces)
N = exponent for surfaces, usually determined experimentally for each configuration
R_{film} = effective electrical resistance, microhm, of film (zero for clean surfaces)

Constant K and exponent N have known values for certain simple configurations. For clean, crossed-rod contacts, plastically deformed, $K = 0.886$, $N = 0.5$; for fairly clean flat-

plate contacts, $K = 0.34$, $N = 0.75$. Minimum value for N is 0.33—for clean surfaces, elastic deformation. Maximum $N = 1.0$—for unclean surfaces.

■ A comparison of contact and plating materials is made in the table. An arbitrary "figure of merit" is assigned—the product of ρ and $\sqrt{P_{flow}}$. Low values indicate good contracting qualities. However, if oxides form, the qualities might be lost. The table also lists oxides likely to form.

Material	ρ	P_{flow}	$\rho\sqrt{P_{flow}}$	Oxides formed at 68 F
Silver	0.626	34,000–80,000	116–177	Ag_2O, Ag_2S
Gold	0.96	17,000–80,000	126–281	——
Aluminum	1.11	20,000–100,000	156–350	Al_2O_3
Copper	0.68	120,000	236	CuO, Cu_2O
Tin	4.53	7,500	394	SnO, SnO_2
Rhodium	1.77	100,000–300,000	560–972	——
Brass	2.96	140,000–190,000	1100–1300	Copper and zinc oxides
Platinum	4.18	80,000	1185	——
Nickel	3.54	310,000	1970	NiO

Aluminum, for example, would be an excellent contact material except for its tenacious, rapid-forming oxide film which must be removed by contact wipe with resulting wear. Tin has desired softness, but high resistivity. Copper has low resistivity, but is hard. One answer—proven adequate for many contact applications—is the combination of soft tin plate on a low-resistance copper contact. Innumerable other combinations are of course possible.

But watch out for galvanic corrosion. Salty atmosphere will deteriorate some metal combinations, but not damage others. Poor combinations are: aluminum with copper; tin-plated aluminum with copper; aluminum with nickel-plated or silver-plated copper; aluminum with gold-plated copper.

Combinations resistant to galvanic corrosion include copper with nickel-plated or gold-plated copper; tin-plated copper with aluminum; many (but not all) combinations of plated copper with plated copper. Copper with solder-dipped copper is fairly good . . . shows slight corrosion.

resonant frequencies) and materials with good damping characteristics.

Surface corrosion and contamination will increase resistance between contacts and, in extreme cases, spoil the connection. No simple rule can choose the right combination of materials and design to give the life and performance needed in poor environments—there are too many variables. However, these basics are a guide:

- Oxides and contaminants can destroy effectiveness of a connector long before mechanical damage is apparent.
- Mild corrosion (tarnishing, for example) and normal contamination are readily removed during insertion if sufficient wiping occurs. For copper and brass surfaces, 0.1 in. wipe with a few pounds of load is enough.
- Severe corrosion in adverse atmospheres can be prevented or diminished with platings.

In choosing platings, electrical performance and wearing properties must often be sacrificed to give good corrosion protection. In "Contact Theory," important properties are given for typical platings and contact materials. Gold, for example, has high electrical conductivity, is free of oxide films, is relatively soft. Therefore, it makes good contact with low force and little wipe, and wears well. For gold-plated contacts, 0.002 in. or more wipe, 6-8 oz load will remove dust and contamination. But even with extremely small thicknesses, the cost of the actual gold exceeds that of the labor to put it on, increasing total cost of connector by as much as 50%.

Less expensive platings such as tin—or no plating at all—will often do the job, if a suitable configuration for the connection can be found.

REPRINT COPIES of this report are available for 25 cents each by addressing Readers Service Dept., Product Engineering, 330 W 42nd St, New York 36, NY.

EDITOR'S NOTE: The broad topic of static electrical connections has been thoroughly explored in these previous articles:

Reliability of Electrical Connections, Feb 2 '59, p 54, is an engineering analysis of the Third Annual EIA Conference, covering all types of permanent and separable connections.

Metal Coatings for Electrical Connections, Nov. '56, p 191, compares resistivity, hardness, galvanic action and other properties of plated, dipped and bare-metal surfaces.

ASTM Symposium on Soldering, Aug '56, p 369, summarizes state of art; covers corrosive fluxes, gray tin formation, soft solders at high temperatures.

Ultrasonic Soldering of Aluminum Dec '54, p 303, describes magneto-striction method that does not require flux.

Compression Terminals for Aluminum Conductors, Sept. '54, p 160, describes hollow cartridge with inhibitor compound of metal powder suspended in petrolatum.

Wrap-around Connections, June '53, p 230, is original description of wirewrap tool developed by Bell Labs.

Multicontact Electrical Connectors, Nov '52, p 184, describes Cannon connectors.

Dynamic electrical connections, such as contacts on switches and relays, are discussed in these two articles:

Relay Specifications, June 8 '59, p 88 describes the force-function technique for measuring contact performance.

Which Snap-action Switch, April 13 '59, p 58, compares all standard single-pole designs, discusses contact force, area, wiping action, max current, other performance criteria.

overload protection for
GEARED DRIVES

When a machine jams, something has to give. And a gear reducer in the drive compounds the problem of defense. This analysis shows how to obtain the protection needed—at lowest cost.

ARTHUR TERRY
Flexidyne consultant
Dodge Manufacturing Corp

When a sudden overload stalls a geared drive, damaging forces on the drive come from two sources: overload torque capacity of the motor (a constant), and the momentum in the motor and gearing, which varies with the stopping rate.

On gradual overloads, maximum motor torque is the controlling factor and the usual motor-overload devices will give adequate protection. But sudden overloads from jamming, failure or improper operation require some form of fast-response torque-limiting device to isolate the stored energy in both motor and gearing. These devices include shear pins, friction clutches, and hydraulic or dry-fluid drives. The one best type depends on running speeds, stored energy, rate of overload application, and cost.

The protective device must, of course, carry normal starting and running torque, with the maximum starting torque of the motor the determining factor. This is usually 250% of the full-load torque. But the torque release must be sensitive enough to prevent mechanical damage under the highest rate of load application.

Where overloads are infrequent or improbable, with no personal hazard, cost must be weighed against mechanical damage and loss of production. A simple shear pin may be the answer. But the presence of human hazards or potentially frequent overloads will call for more effective protection.

When expected overloads are not sudden, protection between motor and reducer may be all that is needed on a low-ratio drive. Speeds at this point are high enough for a centrifugal clutch to do the job. It can be set to slip at less than motor overload capacity. However, these devices usually are not adjustable out in the field and are subject to wear—which may drop the torque capacity below the starting torque. Also, the difference between static and dynamic friction may offer some difficulty in precise adjustment.

With a high-ratio drive the stored energy in the rotating parts of both the reducer and motor supplies the major part of the momentum. A torque-limiting device between motor and reducer can isolate the momentum of the motor but will not protect the machine from the inertia in the reducer—which can be high for high gear ratios.

For protection on the reducer output side, a larger and higher cost torque-limiting device is required because the torque is greater. Centrifugal devices are impractical at low speeds, limiting the selection to friction clutches or shear pins—but a shear pin is impractical if overloads are expected frequently.

Hydraulic drives give somewhat limited protection against sudden overload because torque capacity varies with slip. On a shock overload a fluid drive at 100% slip may transmit many times the torque capacity of the motor until motor speed drops 25 to 50%.

A dry-fluid drive such as the Flexidyne—which uses fine steel shot as the "fluid"—will slip under overload at about 30% above the starting torque for which it is set, and it can be adjusted in the field. This device thus can provide overload protection at less than the maximum starting torque of the motor.

On a sudden overload—when a machine jams up—the resistance of the overload exceeds the torque capacity of the motor and rapidly decelerates the motor and gearing. Stress on the drive depends on the stored energy in the motor and gearing and the rate of deceleration.

Every machine has some elasticity and looseness, and even the most sudden jamming will allow some time to bring the drive to a stop. A wheel rotating at 1800 rpm makes one revolution in 1/30 sec, and a jam that stops it in 10° rotation would take less than 0.001 sec. Obviously, a stop this sudden would place destructive loads on the drive. With usual elasticity in the system, stopping time is much longer—in the range of 0.01 to 1.0 sec—depending on the momentum in the machine.

To show the effect of stopping time on loads imposed,

Centrifugal devices for high-speed shafts

TYPE	ADVANTAGES	LIMITATIONS
Centrifugal clutch	Simple, inexpensive	Field adjustment difficult Wear influences setting
Hydraulic fluid drive	No wear	Slipping torque builds up to approx. motor breakdown torque Not readily adjustable Torque varies with temperature Expensive
Dry-fluid drive	Simple, inexpensive Precise torque setting, even near running torque Adjustable in use	Requires additional protection for slipping loads

Constant-torque devices for low-speed shafts

Shear pin	Simple, cheap	Inaccurate release torque Difficult to replace
Friction clutch	Simple	Settings not precise Torque changes with wear

consider a typical drive with a 10-hp motor and a 10:1 gear reducer.

Torque and inertia at motor shaft and gear output for stopping times of 1, 0.1 and 0.01 sec are calculated in the accompanying table.

	At motor	Leaving reducer
Full-load motor torque	30 lb ft	300 lb ft
Breakdown motor torque	75 lb ft	750 lb ft
Inertia	2.0 lb ft²	0.2 lb ft²

	Stall time, seconds		
Torque with no overload protection	1.0	0.1	0.01
Motor torque	75	75	75
Motor inertia*	11	110	1100
Reducer inertia*	1	11	110
Total	87	196	1285
At reducer output, ft-lb	870	1960	12,850
With dry-fluid clutch on motor shaft set for 50 lb-ft			
Motor torque	50	50	50
Motor inertia	0	0	0
Reducer inertia	1	11	110
Total	51	61	160
At reducer output, ft-lb	510	610	1600

* Deceleration torque lb-ft = $WR^2 \times rpm/309\ t$ (t in sec)

For a 0.01-sec stall with no protective devices the torque at the reducer output can reach 12,850 lb-ft, with the motor inertia being the major element. With a shear pin or clutch set for 1000 ft-lb in the reducer output a 1-sec stall would involve no slippage or replacement of shear pin, while a stop of 0.1 sec would shear the pin or slip the clutch.

With a dry-fluid clutch between motor and reducer set for 50 lb-ft, major part of the stall torque comes from the reducer inertia, and on a sudden 0.01-sec stop could reach 1600 lb-ft torque on the reducer output. This could be limited by addition of the slipping clutch or shear pin already considered.

For a wide range of overload, this combination of a dry-fluid clutch between motor and reducer with a shear pin on the reducer output shaft can provide adequate protection against sudden overloads without letting go under starting loads. Under all but the most sudden jamming the clutch will slip and the drive can be restarted as soon as the overload is cleared. The shear pin would have to be replaced only when the drive had to take an unusually severe shock.

If the drive operated unattended and a moderate overload might cause continual slip in the clutch, a zero-speed (plugging) switch on the reducer output shaft can stop the motor and signal the need for attention. ■

Does your product deserve an award?

Product Engineering is instituting the first of a series of Annual Awards For Achievement in Product Development. The purpose; recognition for a job well done, plus the publication of the biography of a product-development program so that others may learn something from an award winner's experience.

Excellence of engineering and appearance, fulfillment of design objectives will, of course, weigh heavily in determining the recipient of these awards, but the degree and quality of integration between engineering, design, manufacturing and marketing personnel and resources will be equally important.

To be eligible for the first year's award a development program must have introduced a product for sale between March 1, 1959, and February 29, 1960. The product will probably incorporate metal or plastics and have required one or more processes of manufacture, such as machining, molding, extrusion, forming, assembly. The product may not contain its own power source, but it will almost certainly use or transmit energy in some form. It probably will include moving parts and their control.

Judges will award as many citations as they feel are warranted, based on the excellence of the entries. There will be no rating of awards relative to each other.

If you would like an entry blank and more information just write "Awards" in the space marked Special Data on the Reader Service card bound in this issue, add your name and address and send it along to us.

what the tests show about

SOLDERED ALUMINUM JOINTS

W McQUILLAN
Materials Engineering Dept
Westinghouse Electric Corp

There are dozens of aluminum solders to choose from and each has its own characteristics. Here's how they're used and how they will act in time.

Effective life of a soldered joint ends when it can no longer carry its required electrical and mechanical loads. For aluminum soldered joints corrosion limits the life and loss of electrical conductivity follows soon after loss of strength. Although soldered joints should not be mechanically stressed in normal use, because of poor creep, this loss of strength in aluminum-to-aluminum joints is a good indicator of relative life.

Accelerated corrosion tests in both salt spray and high humidity have shown the same relative order of resistance to corrosion as actual outdoor tests in the industrial atmosphere of East Pittsburgh. The specimens, 3 in. x ¼ in. by ⅛ in. thick, with lap joint areas approx 0.07 square in., were tested daily by supporting the joint as a simple beam and placing a 5 lb load at the joint area. The life—the number of days they still could carry the load—is plotted in the chart below. The zinc base solders with about 5% Al appear to be best but must not be contaminated. Copper-to-copper soldered joints are also shown for comparison. These, in general, showed good life.

OXIDE PROBLEMS

A tightly adherent oxide coating gives aluminum its corrosion resistance, but it is also the chief barrier to a well-soldered joint. Solder will not wet the oxide, which therefore must be dissolved by corrosive fluxes or bodily removed by mechanical disruption of the surface layer.

MECHANICAL METHODS

These are slower and most convenient for small-lot soldering. Fluxes are unnecessary but a strong joint depends on operator skill.

Relative Strengths of Some Soldered Joints

Solder	Joint Area, square inches	Tensile-shear Strength, psi
Aluminum-to-aluminum		
65% Pb, 3% Zn, 32% Sn.	0.04	3825
90% Sn, 10% Zn.....	0.050	5812
60% Sn, 40% Zn.....	0.052	6578
95% Zn, 5% Al.....	0.0501	9374*
Copper-to-copper		
60% Pb, 40% Sn.....	0.028	5420

* Specimen failed in the aluminum base metal.

An abrasive tool or brush is used to scrape the surface under a pool of molten solder, in the simplest method. The solder coats clean metal immediately behind the brush. Brushes may be glass or wire; solders are usually tin-zinc alloys. Soldering irons with vibrating wire brushes in the tips are available. With this type of material heat sources should have enough thermal capacity to heat the metal parts above the melting temperature of the solder alloy itself.

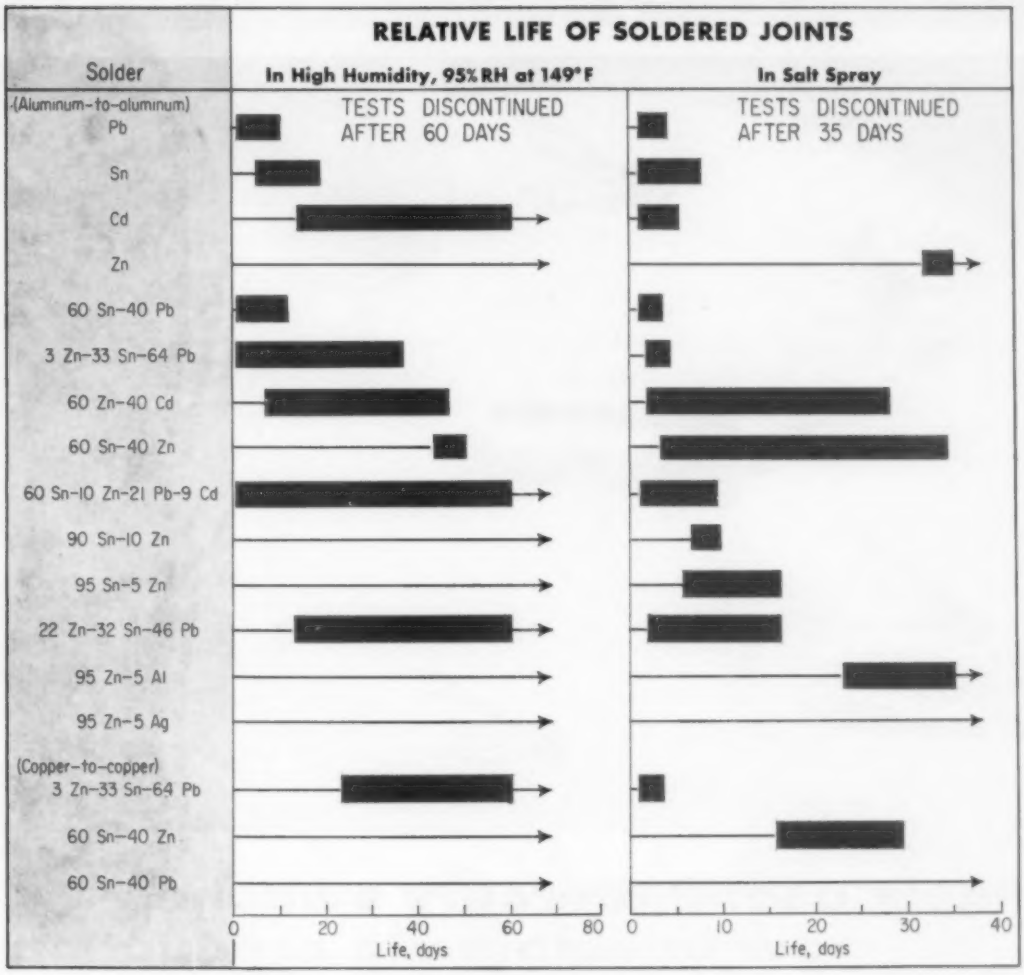
Vibration replaces abrasive brushes in a more elaborate method. The heated parts sandwich a layer of molten solder or brazing alloy and are then vibrated in a direction perpendicular to the plane of the joint. Watch for fatigue loads on the parts. Aluminum-silicon brazing alloys have been the most successful with this method. Normal aluminum soldering alloys are less satisfactory.

Solder-loaded emery wheels can tin an aluminum surface. Friction heats the surface to the melting temperature of the solder and abrading action removes the oxide. But this method, like the vibration method, puts a mechanical load on the parts so neither method is applicable to fragile sections such as thin wire or foil.

In rub tinning the heated surfaces are rubbed with a solder stick. The oxide is removed and wetting occurs only in well-rubbed areas so joint quality is highly dependent on operator skill. Solder will smear over oxide-coated areas without wetting them and look deceptively well tinned. Alloys used are zinc base with long melting ranges so that the stick remains solid enough to abrade the surfaces. A zinc-base die-casting alloy with 4% Al and about 2% Cu is considered best for rub soldering. In production, these aluminum zinc alloys are subject to intergranular corrosion and failure if the lead, tin, cadmium or bismuth contents exceed 0.005% so zinc alloys used for this purpose soldering must be kept extremely pure.

The zinc-base alloys can also join aluminum to copper, either by rub soldering or by flux soldering. Joining times are critical and must be kept to a minimum because brittle zinc-copper intermetallics are formed and, when they exceed certain critical thicknesses, cause brittleness increasing the likelihood of thermal or mechanical fatigue. However, soldering times are difficult to control in manual soldering and they risk either inadequate heating or poor adhesion and brittle joints.

Gallium is another rub-tinning solder material that can tin at near room temperatures. After tinning, the parts are soldered with tin-lead. Gallium, however,



penetrates grain boundaries in aluminum and embrittles the parent material.

Ultrasonics can disrupt the oxide film and, with enough energy, even tin aluminum through enamel-insulated wire, especially if high temp and aluminum-silicon brazing alloys are used. Part and solder must be hot, but ultrasonics assures more completely tinned joints without flux. Solders with low zinc content are best for this technique as the high-zinc solders rapidly dissolve the parent aluminum under ultrasonic energy.

FLUXES

Fluxes for aluminum soldering fall into two temperature classes. The low-temperature fluxes are fluoride salts in a viscous organic carrier. When heated above 570 F, they char and lose their fluxing properties. Residues of this flux should be removed because they are corrosive and their low electrical resistance may cause shorts.

The high-temperature reaction-type fluxes are mixtures of zinc chloride. When heated on aluminum, zinc chloride penetrates the oxide layer and reacts with the parent metal. The aluminum replaces the zinc in the compound and comes off as aluminum chloride fumes which mechanically remove more of the oxide layer. The reduced zinc is deposited on the metal and tins the surface so that the molten solder will wet it. When soldering with a zinc-based solder the fluxes should be free of tin, lead, cadmium or bismuth salts to avoid intergranular corrosion at the aluminum-zinc interface.

Another type of reaction flux contains a larger proportion of zinc chloride. The reaction deposits enough zinc to form a fillet in a T joint. These high-zinc reaction fluxes are generally mixed with alcohol and applied to parts to be furnace soldered. These reaction fluxes are more corrosive than the fluoride fluxes.

EDITOR'S NOTE: For more about soldering applications, see p 71 of this issue for a special report:

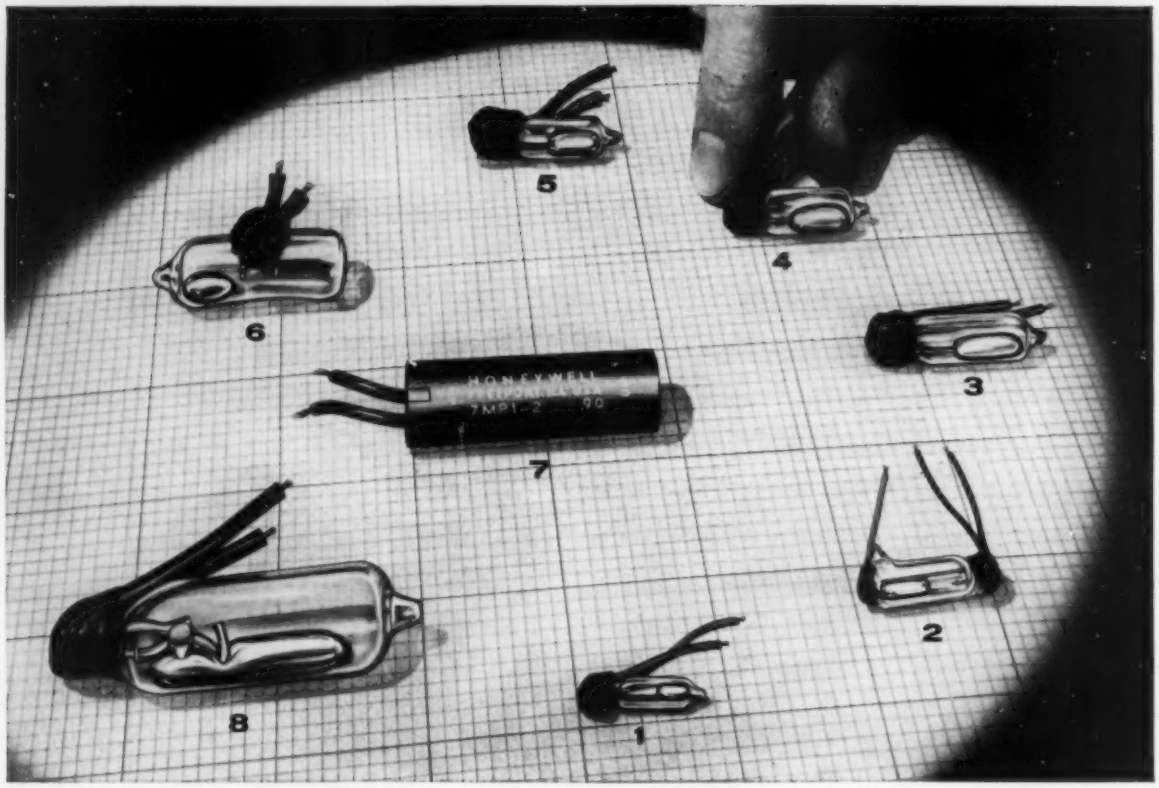
How to Choose the Right Electrical Connection—direct comparisons among all electrical connection methods.

For two articles describing another method of joining aluminum to aluminum:

Which Adhesive for What? Mar 17 '58, p 79, tells what a good structural adhesive must do, compares basic types in chart form, and gives a simplified shopping list.

How to Calculate Stresses in Adhesive Joints, July 7 '58, p 64, analyzes six basic joints and shows how to calculate stress concentrations in each.

MICRO SWITCH Precision Switches



8 widely useful mercury switches now in automatic production

1 AS419A1—Length: 0.90″. Combines smallest available size with long life and reliability. Weight: 0.9 gram (without leads). Tube diameter: 0.174 nominal. SPST.

2 AS603A1—Length: 1.060″. Ultra small, super-sensitive, sealed. The most precise mercury switch available. Weight: 3.5 grams (including leads). SPDT.

3 AS417B2—Length: 1.500″. Offers small size with 3 amps. capacity at 115 vac or vdc.

4 AS408C1—Length: 1.375″. Nominal rating of .25 amp. at 1.5 vac or vdc, also operates in micro-volt and milli-ampere ranges.

5 AS408D1—Length: 1.375″. An economical switch widely used in appliances and vending machines. SPST. Rating: 1 amp., 115 vac or vdc, resistive.

6 AS702B1—Length: 1.625″. Mercury pulse switch has curved glass tube. Used in business machines, counters, timers, etc. SPST.

7 7MP1-2—Length: 1.875″. Embedded in synthetic rubber and enclosed in a nylon can. Resists shock, corrosive fumes, and fungus. Unaffected by oil, water, detergents. Operates in temperatures from −35° to +200°F. 3 amps., 115 vac or vdc, resistive. SPST. Passes 1,000-volt short-circuit test.

8 AS454A34—Length: 2.500″. Medium size. Handles loads up to 10 amps., 115 vac, resistive. Sealed contacts. Low force tilt action. Wide use—machines, tools, appliances, etc.

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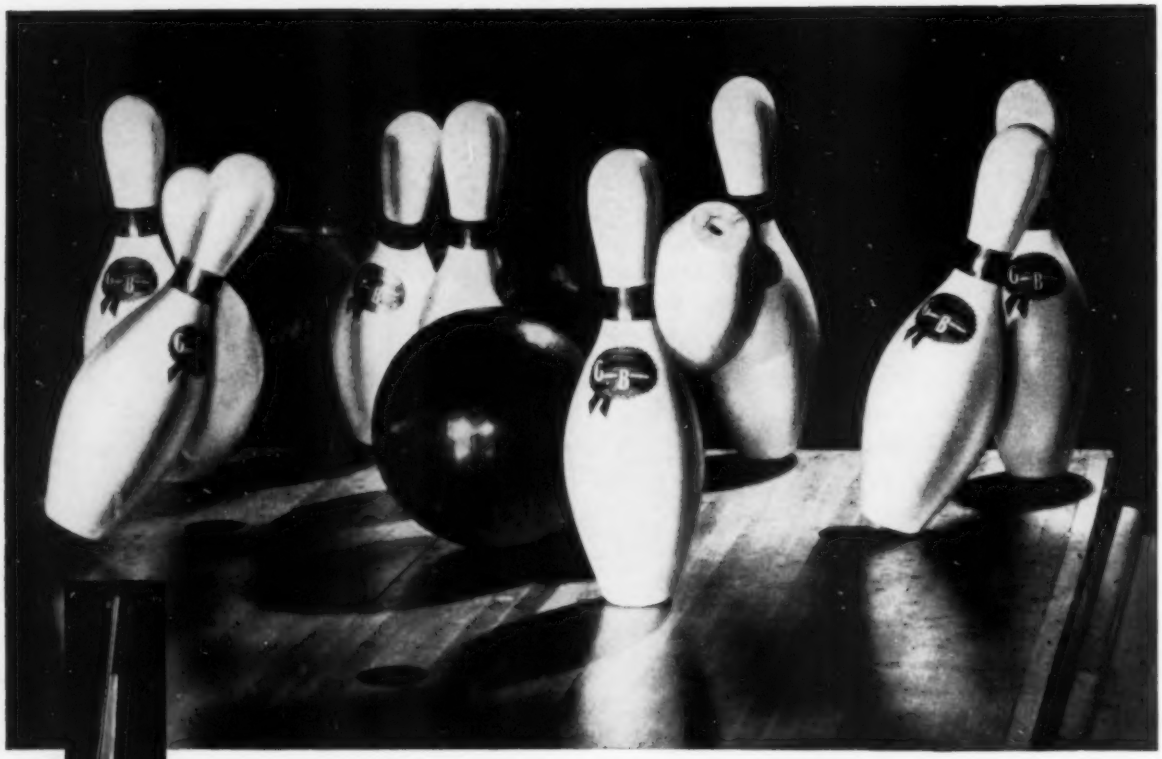

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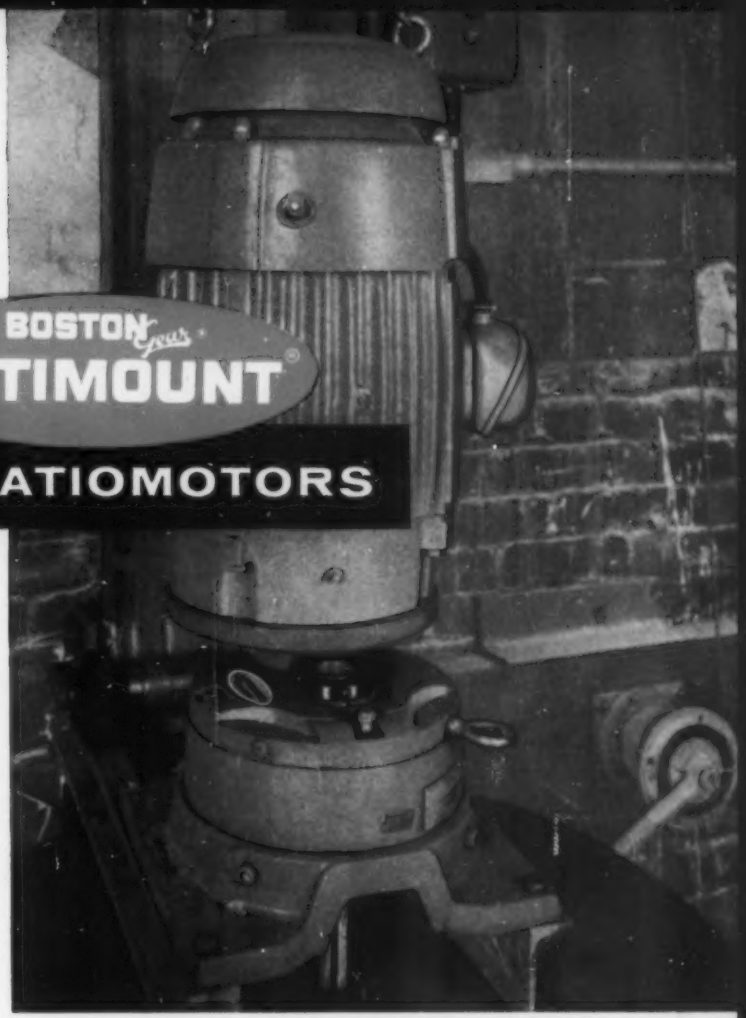

VERTICAL BASE MOUNTED OPTIMOUNT RATIOMOTOR drives agitator blade shaft on pigment mixers in coated textiles plant. Manufacturer says: "OPTIMOUNT adaptability permitted simplified, efficient design for our specific needs . . . at a much lower cost for the complete installation."

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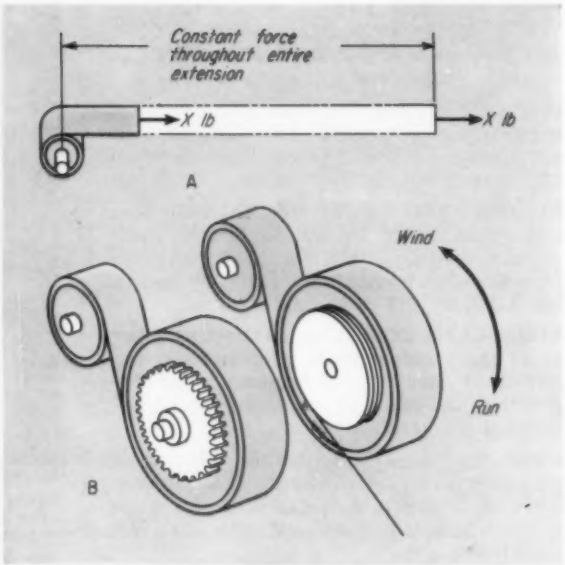
7 APPLICATIONS FOR THE

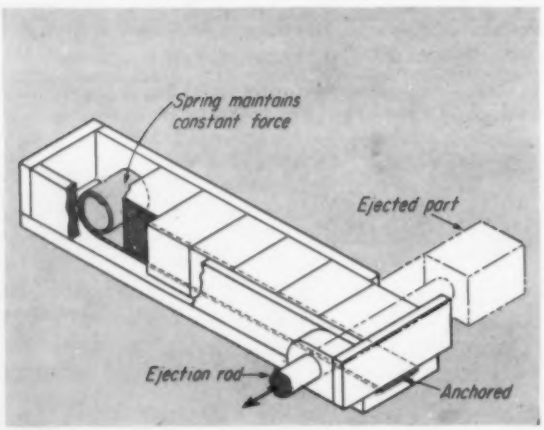
This spring, known as the Neg'ator, finds some up-to-date applications in a magazine feed, one-way brake, motion transfer device, mechanical servo and lifting jack, etc.

HARRY E. NANKONEN
design engineer,
Hunter Spring Co, Lansdale, Pa

1

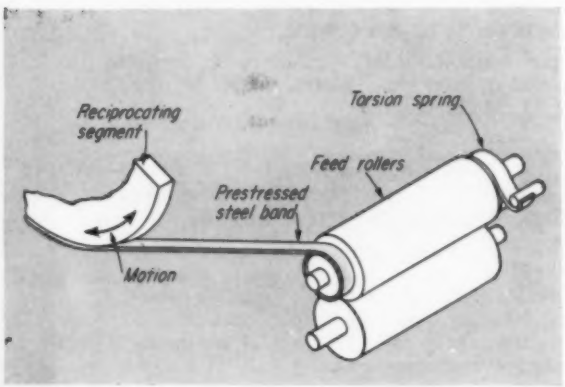


Strip of spring material . . .
prestressed, formed into a tight coil, and mounted on a freely rotating drum (A) resists withdrawal from the coil with a force that remains constant throughout any extension. In this form the Neg'ator is widely used as a long-deflection spring to perform such functions as counterbalancing, constant-force tensioning and retracting. Spring motor (B) is a second basic form of spring. Here the band is extended and reverse wound about a larger dia output drum. Motor produces almost constant torque throughout entire rundown—50-60 turns or more.



2

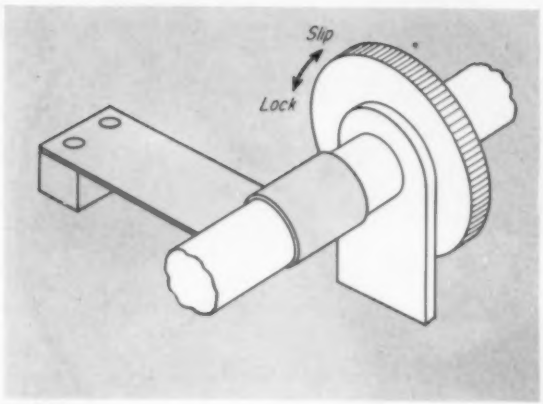
Magazine feed . . .
is powered by the self-adjusting coil of extended spring pushing against material being fed. Long feed has no force variation. Device advances work in machine tools and feeds products in vending machines. Assembly stations, where parts must be fed one at a time, can often be made more efficient with these feeds.



3

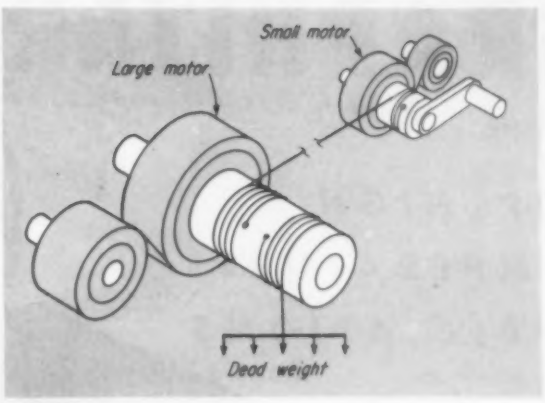
Motion transfer . . .
is quiet and accurate; band replaces gears, transmits oscillating motion of cam-operated segment, produces accurately registered rotation of feed rollers. Steel band is prestressed to insure dimensional stability. Torsion spring returns rollers to starting position.

CONSTANT-FORCE SPRING



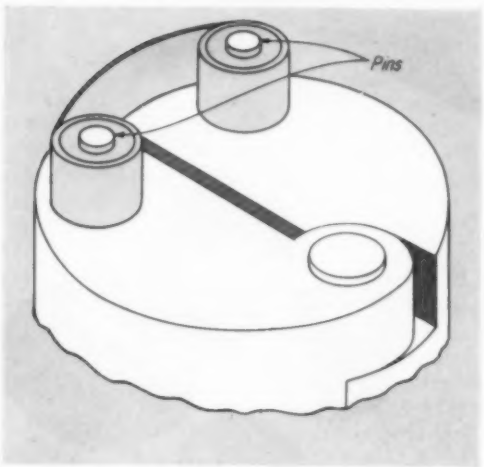
4

One-way brake . . .
prevents counter clockwise rotation of this mechanism, as spring tends to grip more tightly. Clockwise rotation expands the spring coil, lets shaft slip. There is no backlash.



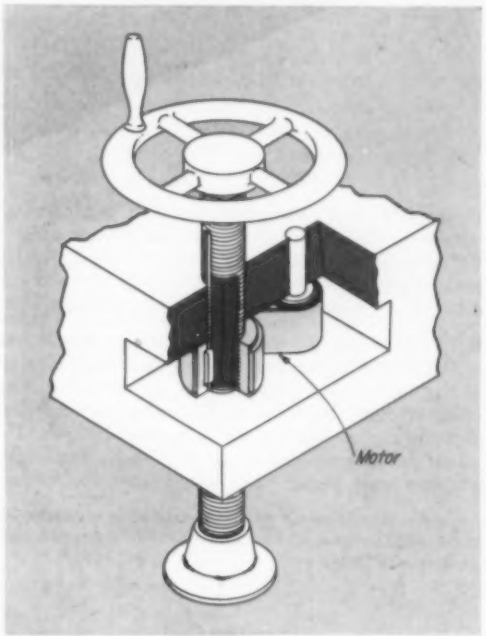
5

Mechanical servo . . .
is formed by two opposed, cable-connected motors. Larger motor provides an output torque sufficient to support both dead weight and force of smaller motor. Friction keeps system static until the remotely located smaller motor is manipulated. Then, the larger motor and load follow.



6

Governor spring . . .
provides constant resistance to centrifugal force when hinged governor opens. Pins holding equal coils of spring may either be capped or fitted with retaining rings to prevent spring from working off during rotation.



7

Spring-assisted jack . . .
reduces manual effort required to raise heavy equipment. Without added torque supplied by spring motor a larger handwheel is needed for easy operation.

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basic data on:

5 IMPORTANT GASKET MATERIALS

Quick-reference facts to aid selection among paste, felt, cork, rubber, and metallic seals.

FRANK W WOOD JR, *design engineer,*
Vitro Laboratories, Silver Spring, Md.

Here are the characteristics and uses of five important sealing materials.

1. POURED AND PASTE-TYPE SEALANTS

Many cements form excellent gaskets either alone or with asbestos sheeting. They are best for permanent, low-cost gasketing or for temporary, emergency service. Some of the more common materials are: Asphalt, tar, pitch, sodium silicate and calcium carbonate, sodium silicate and asbestos fibre. Casein, cement, oxides of lead, zinc and iron may also be mixed with sodium silicate to meet other sealing requirements such as heat resistance and appearance.

Asphalt is not entirely waterproof, and is soluble either in benzol or toluol. While tar and pitch are not soluble in these liquids, they won't wear as well as asphalt does. Sodium silicate mixtures are generally insoluble in cold water; when mixed with cement an acid-proof compound is formed. Casein is insoluble in water or alcohol, but is attacked by alkalies.

2. FELT

Characteristics: Wool felt has a combination of features not found in any other single material. Highly resilient, with a predictable, permanent set, it is not adversely affected by age, water, oil, gasoline or weak acids. It neither crumbles under pressure nor deteriorates during continuous use. It can withstand 250°F dry for 30 days. Felt is unchanged up to 212°F, but at higher temperatures the wool dries out and becomes harsh to the touch. On cooling, however, it resumes its natural texture. Felt is unchanged at −60°F; at −80°F it becomes only slightly harder.

Typical uses: Mounting channel for plate glass; resilient packing strip to prevent infiltration of dust around glass inserts in instruments; seal against rain, hose spray, etc.

Fabricating methods: Felt can be punched, molded, skived, turned, bound by adhesives or stitching, and bored. Because it is made in sheets, punching and blanking are the most economical fabrication methods. Felt gaskets can be impregnated with various materials to add properties such as fungus resistance and increased stiffness for easier handling.

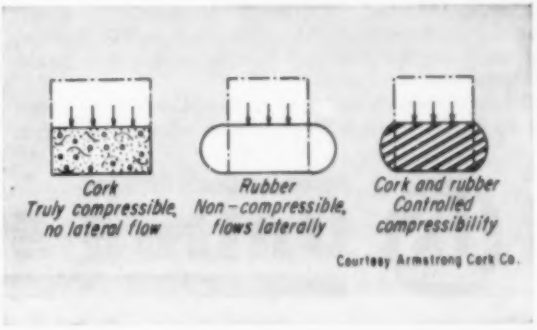
3. CORK

Characteristics: Cork is the outer bark of a species of oak tree. This bark has a unique cellular construction, made up of many tiny cells each of which holds a microscopic pocket of air. There are about 200-million cells in one cubic inch of cork. A thin, thread-like membrane of resinous material binds the cells together. Cork has no "empty spaces" between cells—more than 50% of the volume of cork is air.

Cork compositions are made in a large variety of particle sizes, densities and binders to meet a wide range of industrial requirements. Binders have been developed that are pure and non-contaminating, inert and chemically neutral, with low coefficient of expansion. Research has developed composition cork that is only slightly heavier than natural cork, yet retains nearly all natural-cork characteristics.

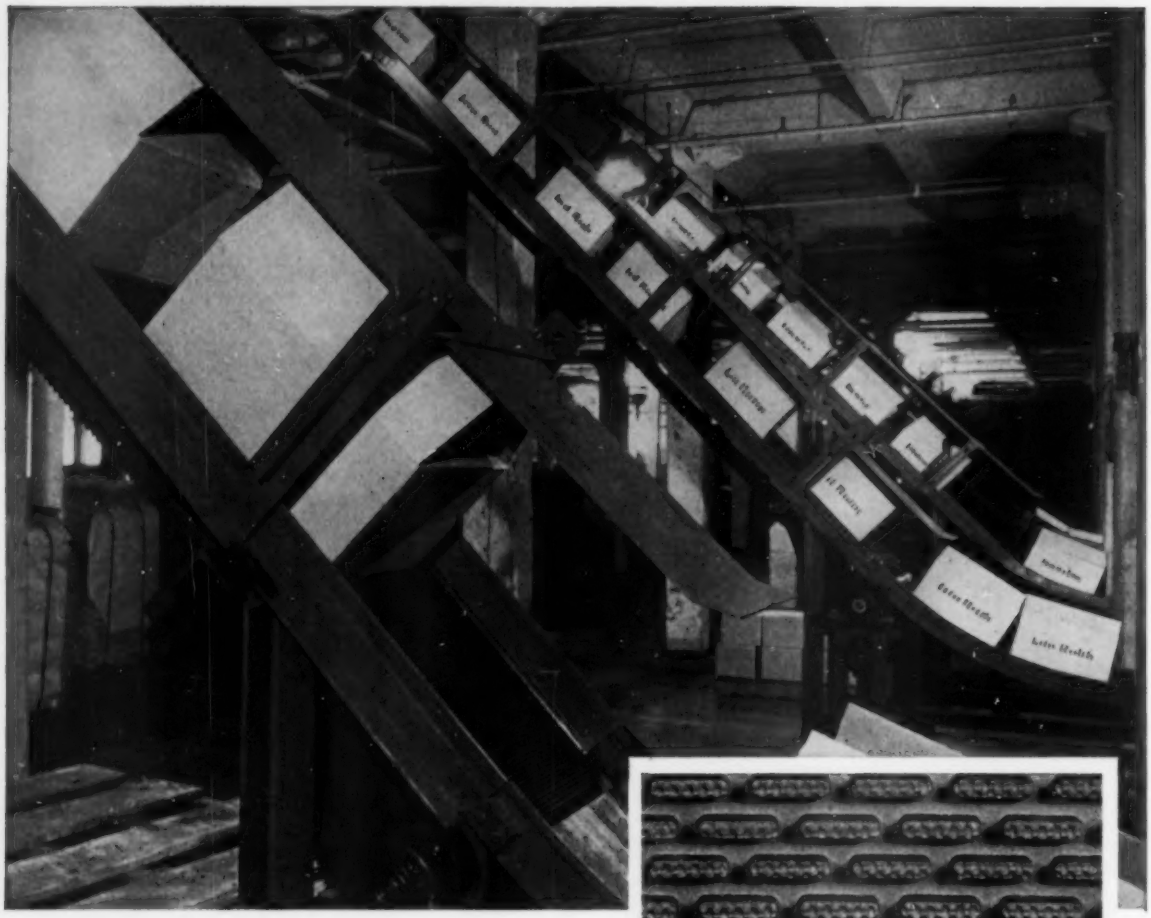
Physical properties of natural cork
Density: 9.5 lb to 13 lb per cu ft.
Tensile strength: 140 to 170 psi (strongest axis)
Compression: (at 100 psi) 4% to 6% (at 3.4% moisture content; compression varies with moisture content)

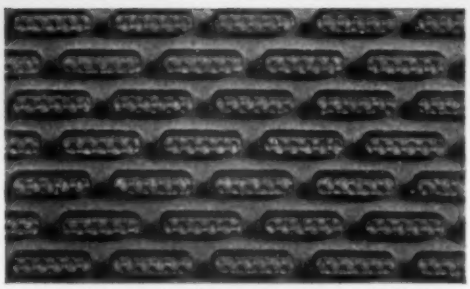
(CONTINUED ON PAGE 95)



Courtesy Armstrong Cork Co.

US STEEPGRADE CONVEYOR BELTING





Exclusive "gripper cleat" construction means the cleats are *not* attached or cut in; they are *molded*—a true and integral part of the belt—and cannot be torn off by heavy boxes.

Whatever became of Gravity?

It's hard to believe that these cartons are not nailed down to the U. S. SteepGrade Belts, so steep is the angle of descent. The scene is the American Can Company's plant in Baltimore, Md., and these light, smooth-finished cartons are being carried at an angle of 45 degrees—*with no slippage*. The sharp angle is necessary because existing floor beams and walls limit the space.

Before the installation of U. S. SteepGrade Belts (there are 10 in all) the cartons went down chutes. This often caused pile-ups at the bottom, with spilled cans, broken cartons and lost tempers. But SteepGrade now offers controlled descent, with cartons evenly spaced. Exclusive "gripper cleat" construction holds the cartons firmly—even at steep, gravity-defying angles—thereby saving valuable floor space, conveyor length and belt footage.

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and the finest quality industrial rubber products.

US Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

5 IMPORTANT GASKET MATERIALS (CONTINUED)

Friction coefficient
Dry cork, on: cork, 0.592; pine (grainy), 0.487; glass, 0.512; steel (dry), 0.452; steel (wet), 0.694; steel (oiled), 0.447; steel (hot), 0.645
Water-soaked cork, on: steel (dry) 0.565.
Oil-soaked cork, on: steel (oiled) 0.419.

Cork is truly compressible. Deformation is almost entirely in the direction of the applied force and is produced by relatively low pressure.

Typical uses: For mating rough or irregular surfaces with low bolting pressures—it will not extrude from flanges even under high loads; as a low-cost oil seal for moderate temperature and pressure ranges.

4. RUBBER

General characteristics: Normal, soft-rubber working range is 15 to 90 Durometer. Safe compressibility limits are about 40% for natural rubber compounds at 30 Durometer to about 20% for compounds at 80 Durometer. Resilience is affected by temperature; reduced temperatures lessen resilience, raised temperatures increase it.

Here six types of rubber are briefly compared:

GR-S (BUNA-S): GR-S compounds have good resistance to abrasion, good heat aging and low water absorption. Tear resistance is less than that of natural rubber. Like natural rubber, these compounds will "check" and crack quickly under strain when exposed to direct sunlight. Aging can be improved, however, by compounding.

NEOPRENE: More like natural rubber than the other synthetic rubbers, it nevertheless has a number of qualities not possessed by natural rubber. Neoprene is resistant to oil, sunlight, ozone, oxidation and heat. It is flame resistant and does not support combustion. Compounds have good tensile strength, high elongation, resistance to tear and abrasion, and high resilience.

BUTYL: Outstanding advantages of Butyl rubber are its chemical resistance and low permeability to gases. It is also highly resistant to weather, aging, sunlight, oxygen, and ozone. It has excellent resistance to acetone, alcohols, ethylene glycol, phenol, furfurol, aniline and salts of copper, cobalt and manganese. Resistance to flex-cracking in many instances exceeds that of natural rubber.

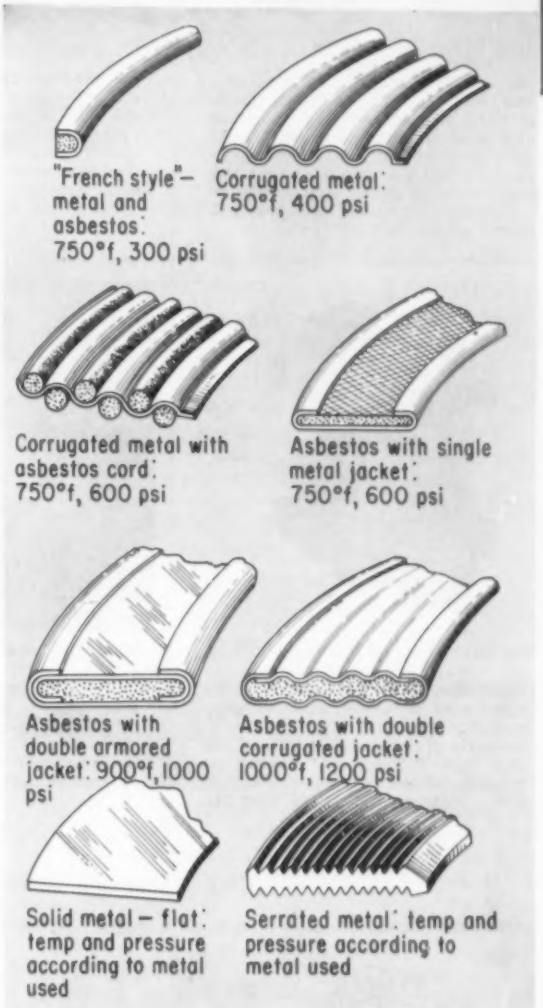
NITRILE RUBBER (BUNA-N): Chief advantages are resistance to oil, gasoline and aromatic solvents. It is superior to natural rubber, GR-S, and Neoprene on heat aging. It has poor flame-resistance and flex life compared to Neoprene.

SILICONE: Silicone has exceptional resistance to heat and cold (−120°F to 500°F), ozone and to oxidation. Silicones, however, have generally poor resistance to compression set. Their flex life is also less than that of most other rubbers.

NATURAL RUBBER: Superior to all synthetic rubbers for developed elasticity, tensile strength, elongation, rebound, tear resistance and electrical resistance. Both natural rubber and GR-S, however, support combustion.

5. METAL-ASBESTOS

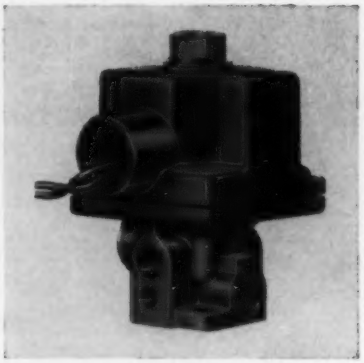
Characteristics: Metals such as copper, steel, stainless steel, monel, zinc, aluminum and brass, either on their own or combined with asbestos, can meet service requirements of extreme temperatures, pressures, and corrosive environments. Some of the many different designs available are shown below.


"French style"—metal and asbestos: 750°f, 300 psi
Corrugated metal: 750°f, 400 psi
Corrugated metal with asbestos cord: 750°f, 600 psi
Asbestos with single metal jacket: 750°f, 600 psi
Asbestos with double armored jacket: 900°f, 1000 psi
Asbestos with double corrugated jacket: 1000°f, 1200 psi
Solid metal—flat: temp and pressure according to metal used
Serrated metal: temp and pressure according to metal used

IN GENERAL, the installation load on gaskets must be sufficient to insure that, when it is relieved by the operational pressure, there must still be more than twice the operational load on the gasket.

For versatile Cylinder Control, specify Skinner 3- and 4-way Solenoid Valves

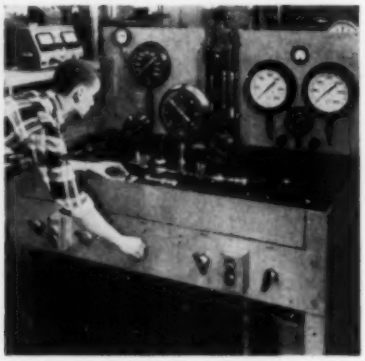
For small cylinders . . . Skinner V5 and V10 air and hydraulic valves. Stainless steel construction. Mount in any position; can be cleaned without removal from line. Pressure ratings to 1000 psi. Available normally open, normally closed, directional control, multi-directional, quick exhaust. Orifice sizes: 3/64" to 1/4".



For medium cylinders . . . Skinner 3 way A Series valves. A new line that can also be used to operate smaller cylinders calling for increased cycling speeds. Die-cast, zinc body; stainless steel internal parts; mount in any position. Available normally open, normally closed, directional control. Pressure to 125 psi; orifice size, 5/32".

Coming soon . . . for larger cylinders! A new-design, general purpose, high-flow industrial line of 3-way solenoid valves. These new valves will be available in orifice sizes of 3/8", 1/2" and 3/4" and will be offered normally open, normally closed, or directional control in standard and explosion-proof construction. Operating pressures: 5 to 150 psi.

For double-acting cylinders . . . Skinner 4-way V9 valves. Two 3-way valves in one housing offered normally closed-normally closed, normally open-normally open, and normally closed-normally open. Available with adjustable flow features for exceptional cylinder control. Orifices: 3/64" to 1/8". Pressure ratings to 200 psi.



Exhaustive lab tests assure that you can use any Skinner valve with confidence. Built to the highest UL standards, Skinner valves are completely tested and checked to provide the best product available. Skinner's testing standards meet or surpass those of the aircraft industry.

A complete line of 2-, 3- and 4-way solenoid valves. There's a Skinner valve for almost any flow application with a wide variety of media: air, oil, water, inert gases, hydraulic fluids, kerosene and gasoline. Orifice sizes range from 3/64" to 1". Pressure ratings range from vacuum to 3000 psi. Explosion-proof models are UL approved for Class I, Group D and Class 2, Groups F and G.

Skinner solenoid valves are distributed nationally

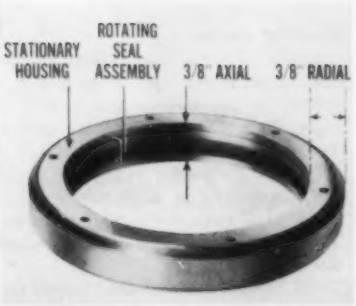
For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 45D.

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

THE SKINNER ELECTRIC VALVE DIVISION • NEW BRITAIN, CONNECTICUT

SIGNIFICANT COMPONENTS MATERIALS PROCESSES



Self-contained shaft seal . . . for temperatures to 450 F is said to resist pressure differentials in one or both directions to 30 psi at shaft speeds to 15,000 sfm. Requires about ¼ axial space usually needed for comparable seals. Units frequently fit existing lip-seal cavities without alteration. Available for shaft sizes from ¼ to 8 in. dia. Seals are reported to retain water, gases and any type of lubricant with viscosity ranging from kerosene to heavy greases. Enclosed seal assembly revolves with shaft with two-point static shaft contact to prevent shaft scoring or wear and to compensate for normal end play and whip. Designed for press fit in housing cavity. Spring-loaded split grip ring transfers rotation from shaft to seal assembly. To achieve high sealing efficiency, mating surfaces are lapped flat to within two light bands. Heat transfer is achieved by pressure relief vents in side plate on wet side. Action of revolving seal assembly dissipates heat and prevents pressure buildup. In lots of 500, 1½ in. shaft size is $10 each. 6-wk delivery on popular sizes. **Universal Grinding Corp, Seal Div, 2200 Scranton Rd, Cleveland 13.**

Circle 300 on Reader Service Card

Shock-resistant epoxy . . . casting system especially designed for embedding electric motor stators and transformers is also suitable for casting or potting large masses where heat curing cannot be tolerated and for potting circuits and transformers having strain-sensitive elements. Castings containing large steel inserts of various configurations have been cycled between —85 and 302 F without cracking. Easily-handled material has pot life of several days at 100m temperature and simplified curing characteristics. **Houghton Laboratories, Olean, NY.**

Circle 301 on Reader Service Card

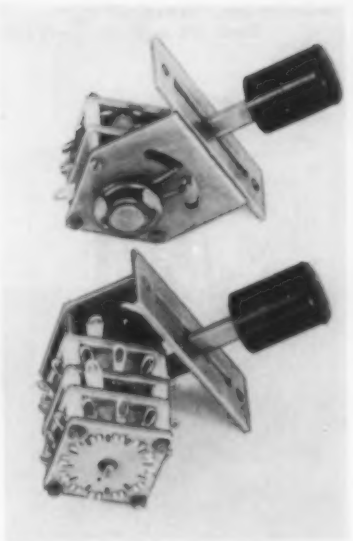
Rotating cam limit switch . . . has speed reducer mounted on steel bed plate connected to shaft by flexible coupling. Can be removed and replaced in one unit. Ten gear ratios (25:1, 36:1, 50:1, 100:1, 150:1, 200:1, 300:1, 400:1, 600:1 and 900:1) are standard. Available in standard NEMA types 1, 4, 5, 7, 9 and 12 enclosures with from 2 to 12 circuits, employing one type cam for all settings. Snap-action switches have one normally open and one normally closed contact, electrically separated. Prices range from $253 to $1180. Delivery in 2 wk. **Gemco Electric Co, 25685 W Eight Mile Rd, Detroit 40.**

Circle 302 on Reader Service Card

In-line filter indicates . . . when filter element needs cleaning. Filter unit can be used with pressures up to 2000 psi and with any of several available filter mediums having openings sized from 238 down to 10 microns. Typical flow rating with 149 micron element at 1 psi pressure drop is 20 gpm. Permits easy access to filter cartridge, full-flow filtering, adjustable max pressure drop control and full by-pass. Housing also permits use of indicating flow meter to spot check flow rates when troubleshooting. About $64 to $85, list. From stock. **Rosaen Co, 1776 E Nine Mile Rd, Hazel Park, Mich.**

Circle 303 on Reader Service Card

Miniature rotary selector switch . . . provides multicircuit control, panel-mounting (for panels up to ¼ in. thick) and lever



operation in unit suitable for low-power and electronic circuits. Can be furnished with one or two sections, giving up to 12-pole switching. Lever actuator can be arranged to be spring-returned to center from either or both end positions or can be maintained in any or all of the three positions, or can be limited to two positions. Basic switch meets MIL-S-3786. Current-carrying parts are silver-alloy material. Rated 3 amp continuous current at 115 v ac; interrupting rating, ½ amp at 115 v ac. Voltage breakdown is 1000 v rms. Single units are priced from about $6 to $10. Delivery, about 3 wk. **Electro Switch Corp, 167 King Ave, Weymouth 88, Mass.**

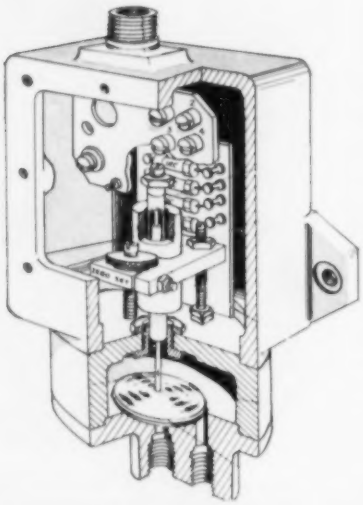
Circle 304 on Reader Service Card

Low-cost epoxy adhesive . . . priced at from ½ to ⅓ the cost per gallon normally associated with equivalent products, is a two-part, 100%-reactive, unfilled, room-temperature-curing formulation. Available in free-flowing viscosity (3000 to 7000 cps) that permits brush application. Originally developed for bonding rigid expanded polystyrene foams to themselves, to metal, wood and other materials, also joins metals and rigid plastics for intermediate strength structural uses. In six-drum lots, mixed cost of epoxy adhesive and its hardener ranges

. . . CONTINUED ON PAGE 98

about $7.75 per gal. At this price, cost per sq ft of bonded surface with glue line 0.005 in. thick is 2.4¢. Pot life with hardener is about 45 to 90 min. Mixed weight is approximately 9.6 lb per gal. **Rubber & Asbestos Corp, 225 Belleville Ave, Bloomfield, NJ.**

Circle 305 on Reader Service Card



Low-pressure transducer . . .

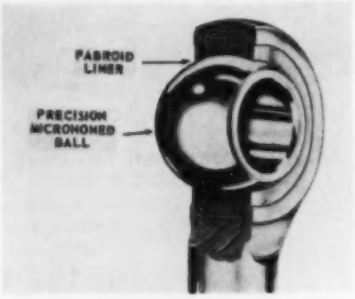
said to perform high-accuracy measurements is available in various forms for measurement of gage, differential and absolute pressures. Sensing cell delivers high-level output signals, up to 1.5 v ac or up to 100 milliv dc with accessory demodulator. Expansion or contraction of sensing capsule results in small displacement of core of differential transformer. Magnetomotive nature of transformer provides infinite resolution. Output signal is, therefore, linear and stepless. Standard ranges available are from 0 to 1.5 psi to 0 to 60 psi, with four intermediate ranges and accuracies to ±0.15% of full range. Zero and range can be adjusted manually. Instrument is sealed in NEMA class IV housing. Guaranteed for life of 10 million cycles min. Cell is about $350; delivery, 6 to 8 wk. **International Resistance Co, 401 N Broad St, Philadelphia 8.**

Circle 306 on Reader Service Card

Low-temperature-curing . . .

silicone impregnating varnish is said to develop optimum electrical properties at cure temperatures of 302 F. Dielectric strength remained over 2000 v per mil after 39 days at 482 F. Low-curing temperature is not damaging to organic insulating components. **General Electric Co, Silicone Products Dept, Waterford, NY.**

Circle 307 on Reader Service Card



Self-lubricating bearings . . .

for heavy loads and low velocities utilize Teflon-glass fabric backed by second fabric of glass cloth impregnated with phenolic. Fabric is woven so that Teflon fibers are on one side, glass fibers on the other. Backing acts as keying agent, restraining movement of glass and Teflon fibers in bearing fabric and assists in bonding the bearing shell. Coefficient of friction between woven Teflon and polished steel is said to average 0.025. **Micro-Precision Div, Micromatic Hone Corp, 8100 Schoolcraft Ave, Detroit 38.**

Circle 308 on Reader Service Card

Momentary contact time switch

for direct control of mechanically-held contactors and low-voltage lighting systems provides a 3 to 5 sec pulse for on or off switching. On-off times are set by placing trippers at precise times on dial that switching is desired. Switch is SPDT. Available with choice of standard dials to fit switching schedule. Units also have manual on-off switch. Housing is less than half the size of original unit. **Tork Time Controls Inc, Mount Vernon, NY.**

Circle 309 on Reader Service Card

High-pressure blower . . .

has thin radial blade construction. Delivers 51 cfm free air and can draw max suction of 7.6 in. water. Provides continuous duty over range of −67 to 185 F. Speed is 11,250 rpm. Input is 85 w; current, 0.33 amp. Motor case is $3\frac{5}{8}$ in. dia; blade housing, $5\frac{3}{8}$ in. dia; over-all length, excluding flange, $4\frac{1}{8}$ in. Weighs 3.1 lb. Operates on 208 v, three phase, 400 cps as standard. **IMC Magnetics Corp, 570 Main St, Westbury, NY.**

Circle 310 on Reader Service Card

Hydraulic gear pumps . . .

are rated at 13 and 20 gpm, 2000 and 1500 rpm, continuous duty. Pumps are said to be pressure-balanced with automatic adjustment of wear plates. Can be used as high-efficiency motor without any modification or adjustment. Design eliminates high pressure bind. May be driven clockwise or counter-clockwise. **Be-Ge Mfg Co, PO Box 67, Gilroy, Calif.**

Circle 311 on Reader Service Card

Electric motors . . .

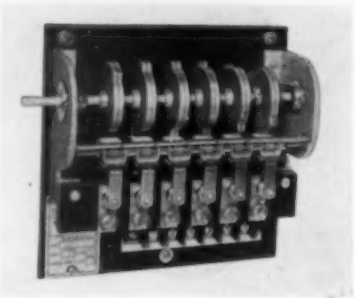
originally designed for continuous and intermittent use at 600 F at 80,000 ft altitude are available to provide 0.05 hp intermittent; 0.5 hp and 15 hp, continuous. All operate on three-phase, 115 or 200 v, 400 cps power. Motors are flexible and can operate on single or three-phase or in servo control systems. **AiResearch Mfg Div, Garrett Corp, 9851 Sepulveda Blvd, Los Angeles.**

Circle 312 on Reader Service Card

High-solids adhesives . . .

said to offer low shrinkage for bonding or sealing of irregular mating surfaces and porous materials, are available in three compositions. Adhesives are rubber-base types, non-curing and gain in strength for 24 to 48 hr after use. **B B Chemical Co, Sub of United Shoe Machinery Corp, Cambridge, Mass.**

Circle 313 on Reader Service Card



Rotary cam limit switch . . .

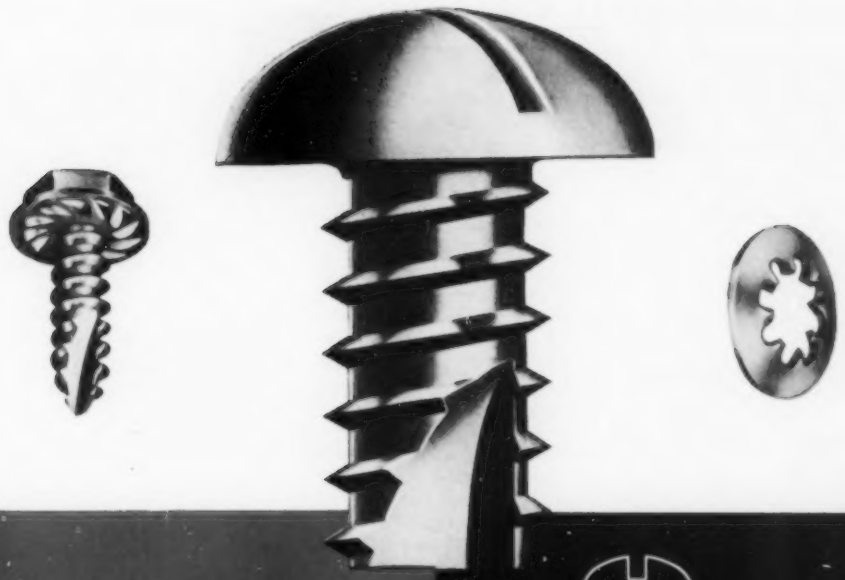
with from 2 to 16 individual circuits has $\frac{1}{4}$-in. cam shaft. Said to operate at speeds up to 300 rpm. $\frac{3}{8}$ in. coin silver inflexible contacts rated 15 amp min. **Eagle Signal Co, 202 20th St, Moline, Ill.**

Circle 314 on Reader Service Card

Electromagnetic circuit breakers . . .

trip within 25 millisec on overloads of 150% of rated current. Available with current ratings from 50 milliamp to 10 amp. Designed to replace fuses, overload relays and operational switches for protection of current-sensitive components.

. . . CONTINUED ON PAGE 100



HOW TO SELECT COST-SAVING

fasteners for plastic

A TYPICAL EXAMPLE:
Cuts its own thread—

Shakeproof's® Type 25 Thread-cutting Screw saves time because it eliminates tapping. Blunt point assures maximum thread engagement and high holding strength when driven into a relatively thin panel.

Shakeproof has pioneered in developing ingenious, cost-cutting fasteners for plastic applications. The screw featured above not only taps its own hole—often it eliminates costly threaded inserts. Another Shakeproof development, the Type 17 self-drilling Nibscrew®, both drills and taps as it is driven. A Shakeproof Dished Lock Washer compensates for differential in expansion between plastic and metal . . . temperature changes won't loosen the assembly.

For highest quality fasteners that assure faster assembly and lower costs investigate the Shakeproof line. There's a Shakeproof fastener to meet your need—or Shakeproof engineers will develop one for your specific application.

WRITE FOR NEW SHAKEPROOF BULLETIN NO. 300
Shakeproof Bulletin 300 shows ten typical, profitable applications of Shakeproof fasteners on products using plastics. Offers free samples for testing. Send for your copy now.

itw

SHAKEPROOF
"FASTENING HEADQUARTERS"®
DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois
In Canada: Shakeproof/Fastex
Division of Canada Illinois Tools Limited, 67 Scarsdale Road, Don Mills, Ontario

CIRCLE 99 ON READER SERVICE CARD 99

Usable to 50 v dc and 120 v ac, 60 or 400 cps. **Airpax Electronics Inc, Cambridge Div, Cambridge, Md.**

Circle 315 on Reader Service Card

Miniature shaft collars . . .

for $\frac{1}{16}$ and $\frac{3}{32}$ in. dia shafts are made from alloy steel. Supplied with high-torque hex socket set screws with plain cup point as standard. Bore size is stamped on face of collar. **Standard Pressed Steel Co, Jenkintown, Penna.**

Circle 316 on Reader Service Card

Solid web hand wheels . . .

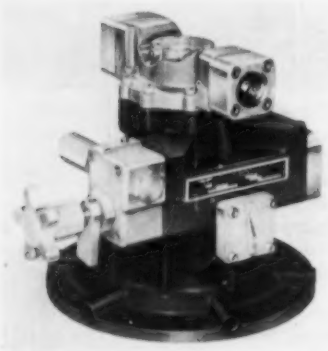
in straight or offset web styles are available in diameters from 4 to 15 in. Made from cast iron and cadmium-plated. Offered as castings only or machined, with solid or revolving handle or no handle. **Machine Products Corp, 6771 E McNichols Rd, Detroit 12.**

Circle 317 on Reader Service Card

Miniature indicator light . . .

supplied with NE-2E neon lamp or 2.5 to 60 v incandescent lamps, mounts in 0.316 in. dia hole in panels up to $\frac{1}{8}$ in. max with 16/32 in. round push-on retainer. Standard lens colors available. **Eldema Corp, 1805 Belcroft Ave, El Monte, Calif.**

Circle 318 on Reader Service Card



Variable-volume pump . . .

for hydraulic service to 5000 psi. Total weight for axial piston unit is 55 lb. Dimensions are $9\frac{3}{8}$ x $10\frac{3}{4}$ in. Operating at 90% over-all efficiency, produces 1.99 cu in. per rev from 1200 to 4000 rpm at 3000 or 5000 psi. Capacity of 8.5 gpm at 1200 rpm and 3000 psi. **Kline Mfg Co, Galena, Ohio.**

Circle 319 on Reader Service Card

Torque of hysteresis motor . . .

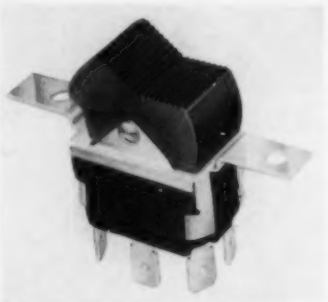
of given size is increased with number of poles while torque of conventional hysteresis motor is constant irrespective of number of poles. For example, 12-pole motor can develop four times more torque than conventional hysteresis motor of same physical size. **Bekey Div, Genisco Inc, 2233 Federal Ave, Los Angeles 64.**

Circle 320 on Reader Service Card

2-circuit switches . . .

for machine tool limit and control mechanisms have median mechanical life that exceeds 10 million operations at full over-travel. Three of snap-action switches have combined stacking width of 2.03 in. Min of 0.080 in. over-travel is provided. Contact arrangement is single-pole two-circuit double-break. UL-listed for 15 amp, 120, 240, 480 or 600 v ac. **Micro Switch, Freeport, Ill.**

Circle 321 on Reader Service Card



20-amp rocker switches . . .

are heavy-duty units. Varied colored serrated actuators may be plain or marked to fit application. Electrically rated 20 amp, 125 v ac, $1\frac{1}{2}$ hp; 10 amp, 250 v ac, 2 hp. Made of impact-resistant molded phenolic. Available in a variety of single and double pole models. UL-approved. **Electrical Div, McGill Mfg Co Inc, Valparaiso, Ind.**

Circle 322 on Reader Service Card

Ac to dc power rectifier . . .

has $\frac{7}{16}$ in. hex stud base and max height of $1\frac{7}{16}$ in. Rated at 13.5 amp average at 77 F ambient on 3 x 3 x $\frac{1}{16}$ in. copper heat sink. Peak inverse voltage range is 50 to 400 v, in 50-v steps. Typical forward dynamic resistance of 0.009 ohm is achieved by diffused junction techniques. **Syntron Co, 240 Lexington Ave, Homer City, Penna.**

Circle 323 on Reader Service Card

Rerated close-coupled motors . . .

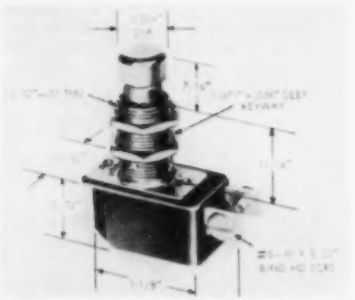
for pumps include dripproof units, from $\frac{1}{4}$ hp at 900 rpm through 75 hp at 1800 rpm, frames 182 through 405U, and explosionproof and totally-enclosed fan-cooled motors from $\frac{1}{4}$ hp, 900 rpm through 30 hp, frames 182 through 326U. Can be furnished for three or two phase operation and in all frequencies and commercial voltages below 600 v. **Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.**

Circle 324 on Reader Service Card

Ceramic permanent magnets . . .

are said to have uniform magnetic properties. Isotropic ceramic magnets are high energy-to-weight ratio units for use in magnetic clutches, lathes and other mechanical holding devices. Shorter lengths are possible than with metallic magnets. Can be situated in electrical circuits without producing a conducting path. **Allen-Bradley Co, 136 W Greenfield Ave, Milwaukee 4.**

Circle 325 on Reader Service Card



SPST pushbutton switch . . .

is said to have high cycle life and positive switching action resulting from internal armature design and heavy silver contact. Push-on, push-off unit is rated 6 amp at 125 v and 3 amp at 250 v. **Sargent Electric Corp, Dept R-1, 630 Merrick Rd, Lynbrook, NY.**

Circle 326 on Reader Service Card

Limit stop assembly . . .

for heavy-duty applications is available from stock in ball bearing and oil-less bronze bearing models with a range of mechanical stop limits from 30 to 4530°. Units are adjustable. Rated for stopping torques to 500 in.-oz. **Pic Design Corp, 477 Atlantic Ave, East Rockaway, NY.**

Circle 327 on Reader Service Card

Flat stainless spring wire . . .

rolled from round precipitation-hardening stainless steel wire is said to have greater dimensional stability than music and

. . . *CONTINUED ON PAGE 102*

Automatic marking of hot steel . . .

Controls by ALLEN-BRADLEY, of course

Here's an interesting job that's gone "push button"—stamping heat numbers on hot steel! Now, from a remote console, the operator automatically sets numbers on the marking head and propels it against the steel. The controls, *of course*, are Allen-Bradley because they provide the continuous reliability that is essential to this production.

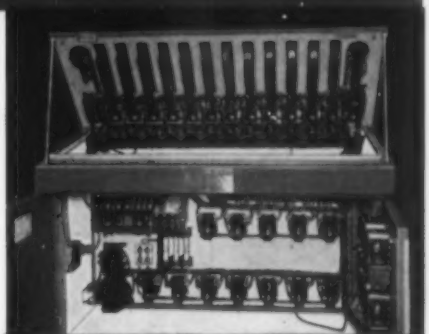
The simple, ONE moving part solenoid design of A-B starters and relays assures millions of trouble free operations. And the double break, silver contacts—used on all A-B control—eliminate costly downtime for maintenance. Keep your production lines rolling . . . insist on Allen-Bradley *quality* motor control. You cannot do better!

Allen-Bradley Co., 1329 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

Member of NEMA

Quality Motor Control

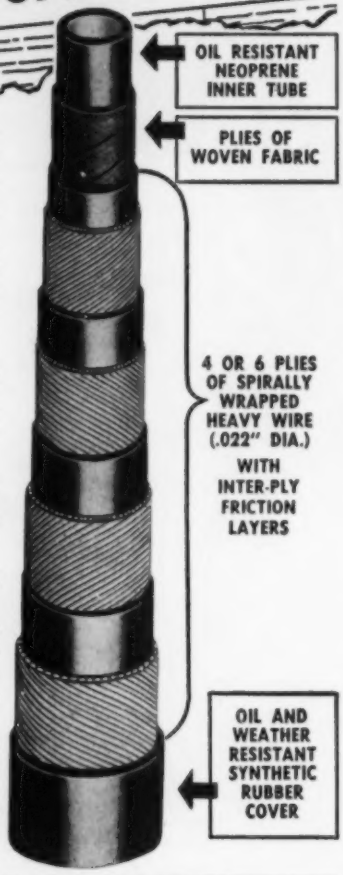


The relays and push buttons used in the remote control console of this M. E. Cunningham Marking Machine are all standard Allen-Bradley catalog items.

CIRCLE 101 ON READER SERVICE CARD 101

EXTRA!

HIGHER HYDRAULIC PRESSURES NOW FEASIBLE WITH NEW ANCHOR "SUPER-SPIRAL" HOSE


OIL RESISTANT NEOPRENE INNER TUBE
PLIES OF WOVEN FABRIC
4 OR 6 PLIES OF SPIRALLY WRAPPED HEAVY WIRE (.022" DIA.)
WITH INTER-PLY FRICTION LAYERS
OIL AND WEATHER RESISTANT SYNTHETIC RUBBER COVER

Designers of hydraulic equipment wishing to increase pressures have been hampered by the lack of dependable, extra high pressure hose. With the introduction of Anchor's "SUPER-SPIRAL" Hose, these limitations have been removed. This hose is already finding wide usage in the replacement of old style braid hose to obtain greatly extended service life.

This hose, available in sizes from 3/16" to 1½" has either 4 or 6 plies of all spirally wound heavy wire reinforcement, with no crossed wires to fatigue, break and weaken hose.

It offers a completely new maximum pressure range for the hydraulic engineer,—opens up new horizons for the hydraulic designer.

- **4 or 6 Plies of Spirally Wound Wire Reinforcement**
- **Maximum Working Pressures from 12,500 psi (3/16" I.D.—6-Ply) to 2500 psi (1½" I.D.—4-Ply)**
- **Heavy Wire, .022" Dia., Reinforcement**
- **All Spirally Wound—No Braid, No Crossed Wires That Lead to Wire Fatigue**
- **Available with Any Anchor Pressed-On Couplings**

Andy Anchor says: You will find all descriptive details and specifications on Anchor's new "SUPER-SPIRAL" High Pressure Hose and the Couplings in a special data sheet now available on request.

I.D.	FOUR PLY		SIX PLY	
	MAX. WORK. PRES. (psi)	MIN. BURST. PRES. (psi)	MAX. WORK. PRES. (psi)	MIN. BURST. PRES. (psi)
3/16"	10,000	40,000	12,500	50,000
1/4"	8,750	35,000	11,250	45,000
3/8"	7,500	30,000	10,000	40,000
1/2"	6,250	25,000	7,500	30,000
3/4"	5,000	20,000	6,250	25,000
1"	4,000	16,000	5,000	20,000
1-1/4"	3,000	12,000	3,500	14,000
1-1/2"	2,500	10,000	3,000	12,000
*2"	2,000	8,000	2,500	10,000

*Under Development

ANCHOR COUPLING CO. INC.

376 No. Fourth St., Libertyville, Ill.
Branch Plants: Dallas, Texas; Plymouth, Michigan

spring wires. Furnished annealed, one-fourth hard, one-half hard, three-fourths hard, or full-hard in bright or copper finish. Widths are available up to 0.300 in. Min thickness is 0.009 in. Modulus of elasticity, 29,500,000 in tension; 11,000,000 in torsion. **Specialty Wire Div, National-Standard Co, Niles, Mich.**

Circle 328 on Reader Service Card

Subminiature switch . . .

for stepping, counting, programming, circuit selecting and homing applications, is now available for immediate delivery. Weighs less than 3 oz and measures 1.5 x 1.375 in. dia. Can be self-stepped or externally impulsed. Actuated by rotary solenoid and remotely controlled. Can hold up to four 12-position circuit wafers with 2, 3, 4, 6 or 12 electrical position selective control. Wire sizes are available to accommodate 3 to 300 v dc. Operates in temperatures of — 67 to 176 F. Withstands shock of 100 g for 11 ± 1 millisec and 50-hr salt spray tests. **G H Leland Inc, 123 Webster St, Dayton 2, Ohio.**

Circle 329 on Reader Service Card

High-strength castings . . .

are said to be possible with an aluminum alloy, to which a small amount of beryllium has been added. Higher tensile strengths are reported with this alloy than from high-purity metal. Substantial price decrease has been announced because of volume use. **Navan Products Inc, 900 N Sepulveda, El Segundo, Calif.**

Circle 330 on Reader Service Card

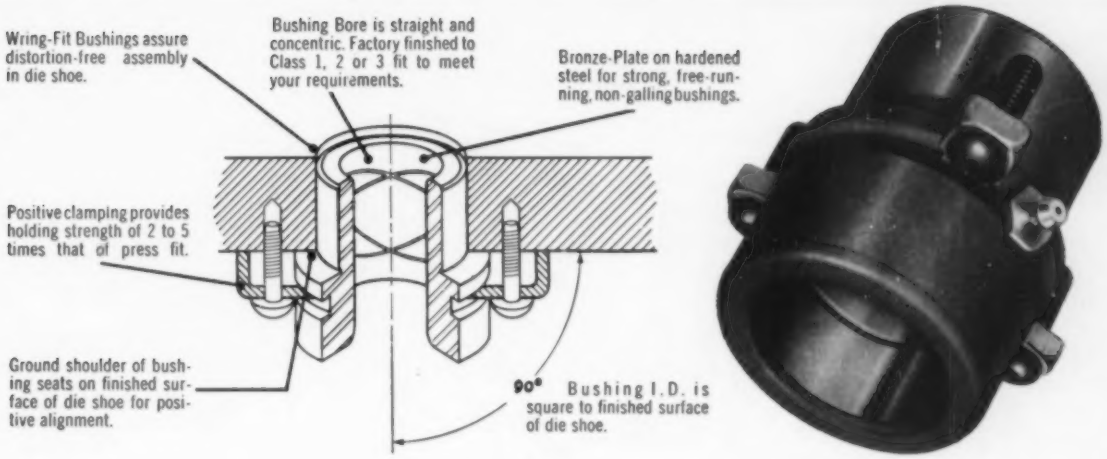
Surface temperature sensors . . .

indicate changing temperatures at repeated transient pressures of 100,000 psi and transient temperatures in excess of 2100F. Available with nickel-steel thermocouple junctions at either 0.0002

(Continued on page 107)

Lower Cost . . . Cut Maintenance . . . Lengthen Die Life

Lamina® BRONZE-PLATED GUIDE PIN BUSHINGS


Wring-Fit Bushings assure distortion-free assembly in die shoe.
Bushing Bore is straight and concentric. Factory finished to Class 1, 2 or 3 fit to meet your requirements.
Bronze-Plate on hardened steel for strong, free-running, non-galling bushings.
Positive clamping provides holding strength of 2 to 5 times that of press fit.
Ground shoulder of bushing seats on finished surface of die shoe for positive alignment.
90° Bushing I.D. is square to finished surface of die shoe.

LAMINA bronze-plated, wring-fit guide pin bushings are honed on the I.D. for accurate geometry, precise dimensions and to provide the best surface finish for lubrication. Bushings are wring-fit in die shoe to assure distortion-free, full-bearing surface that results in better die alignment, less maintenance and longer die life. In addition the Lamina method of clamping bushings to die shoes provides holding strength of two to five times that of press-fit bushings. For more accurate press operation, higher production and lower maintenance costs —standardize on Lamina, the originators of Bronze-Plated Guide Pin Bushings.

Lamina also manufactures: Steel Bushings and Guide Pins, Bronze-Plated Wear Plates, and Bronze-plated Parts. Complete facilities for the manufacture of steel or carbide precision dies (lamination, progressive, transfer, etc.).

Lamina Bushings and Guide Pins are made in types and sizes to meet every requirement. More than 800 items are described and illustrated in our catalog—write for your free copy.

Lamina®
DIES AND TOOLS, INC.
P. O. BOX 31, ROYAL OAK, MICHIGAN

take a card ...ANY card!

...and you'll see why Acheson's EMRALON® is providing new application stories.

The recent introduction of 'EMRALON' surface coatings has literally "opened the door" for scores of manufacturers seeking the unparalleled properties of du Pont's tetrafluoroethylene (TFE) but handicapped by the high fusing temperature. With 'EMRALON' 310*, a one hour cure at 300°F. is all that is necessary. For substrates even more sensitive to heat, there is air drying 'EMRALON' 320†. In either case, these versatile new coatings provide excellent adhesion, low coefficient of friction, toughness and corrosion resistance. What's more, 'EMRALON' can be applied by conventional paint spray equipment.

Why not test 'EMRALON' 310 or 'EMRALON' 320 on your application. Send for an introductory package complete with data sheet. The cost is only $4.25 prepaid for enough material to coat 5,000 sq. in. of surface. ($4.50 west of the Rockies) Write today!

ACHESON COLLOIDS COMPANY
Dept. PE-109, Port Huron, Michigan

Gentlemen: Your new 'EMRALON' surface coatings suggest themselves as possibilities for a current design problem. Send an introductory package to me promptly.

- ☐ 'EMRALON' 310 (bake type) ☐ Check enclosed
- ☐ 'EMRALON' 320 (air-dry) ☐ Please have your service engineer call
- ☐ Bill me on Order No._____ ☐ Send descriptive literature

NAME: TITLE:

COMPANY:

ADDRESS:

CITY: STATE:

APPLICATION:

*'EMRALON' 310 is manufactured under exclusive license from E.I. du Pont de Nemours & Co. (Inc.) under U. S. Patent 2,825,706. Not licensed for use or for sale for use in providing electrical insulation.
†'EMRALON' 320 — Patent applied for

ACHESON *Colloids Company*
PORT HURON, MICHIGAN
A division of Acheson Industries, Inc.
Also Acheson Industries (Europe) Ltd. and affiliates, London, England

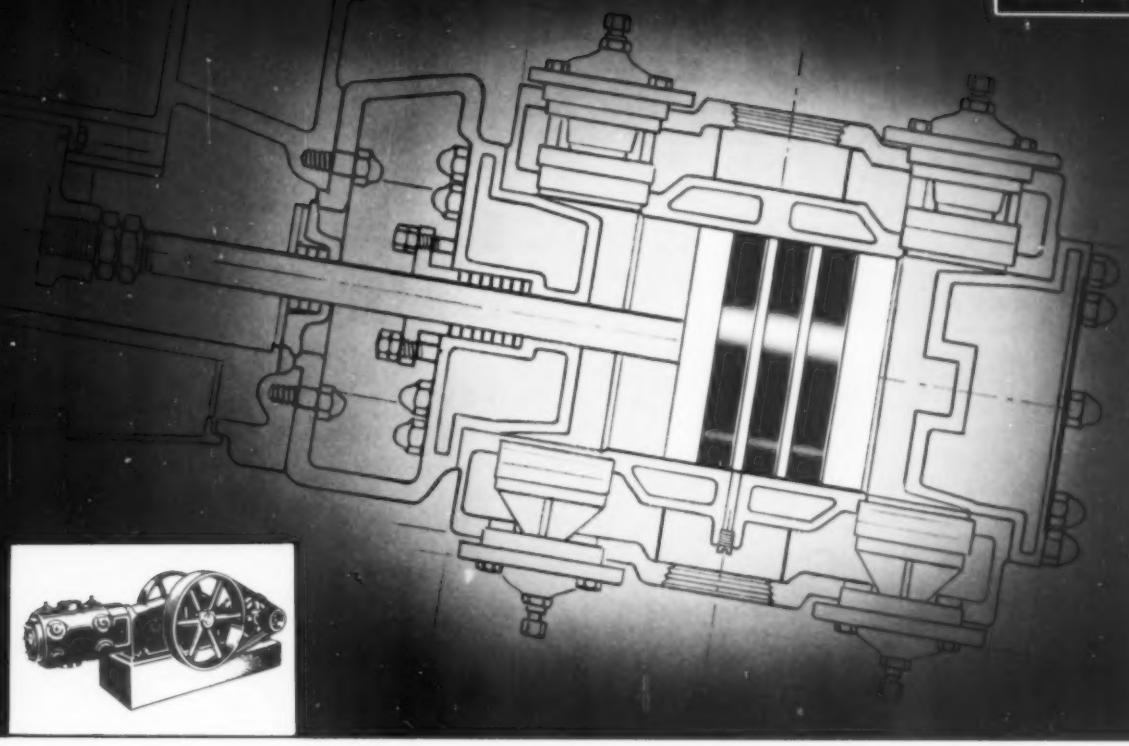
DUPONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number M-6
in a series
MECHANICAL
DESIGN
Floating Rings



Piston rings made with TFE resins cut replacement and maintenance costs

In a heavy-duty compressor, a set of piston rings and wear rings made of filled TFE fluorocarbon resins (shown above) has made possible substantial savings in replacement and maintenance. The rings that were replaced by rings of TFE resins cost two and one-half times as much, and lasted only one week on the average. The rings made with TEFLON TFE resins were still in operation after three and one-half years of service. Maintenance savings according to the manufacturer amount to approximately $3,750 labor/year/machine.

The unique combination of properties offered by TFE resins makes possible improved performance, greater reliability and lower costs in all types of floating-ring applications. TFE resins have the lowest coefficient of friction of any solid materials—less than 0.04. They eliminate problems of stick-slip, and permit the use of non-lubricated rings. In addition, their exceptional resistance to temperature and corrosion makes them ideal sealing materials under adverse conditions. In everyday seal applications as well, floating rings of TFE resins provide longer life, safer and more reliable operation and reduced maintenance problems.

On the next page you will find additional information on the properties of TFE resins that make them advantageous for use in floating rings and additional data on the opportunities they provide for improved seal designs.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

OVER

Design of piston rings made with TFE resins

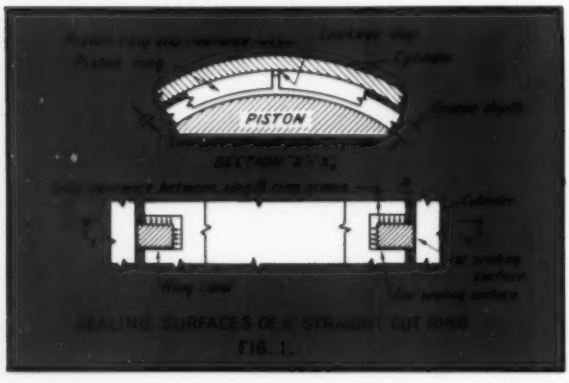
Piston rings and other floating rings are used to seal reciprocating, oscillating and rotary motions of both external and internal cylindrical surfaces against the leakage of fluids. Split floating rings, with an overlapping joint, can handle relatively wide changes of cylinder size caused by thermal changes. High temperatures and pressure have heretofore dictated metallic floating rings; now TFE resins provide ring materials with distinct advantages over metals.

Relevant properties

The static coefficient of friction of TFE resins is even lower than the dynamic value. TFE resins have lower friction than any other solid material, including graphite and molysulfide. They have significantly lower static friction (as low as .016) than the best lubricated metal rings. Rings made with TFE resins have exceptional thermal stability, and maintain their unsurpassed frictional properties from -320°F. to 500°F. They are completely inert to virtually all chemicals and solvents. They are tough and abrasion-resistant, and have the ability to imbed hard foreign particles without damage to themselves or to cylinder walls.

Where to use rings of TFE resins

Piston rings based on TEFLON TFE resins are being used as compressor rings and as hydraulic and pneumatic seals and rings. They perform successfully in areas where lubricated rings are undesirable or cannot operate because of extreme conditions, under highly corrosive conditions, where lubricant failure is possible, where low starting friction and the absence of stick-slip are desirable, where safety and reliability are essential, and, in general, where long, trouble-free performance and reduced maintenance costs are important.



SEALING SURFACES OF A STRAIGHT CUT RING
FIG. 1.

Design considerations

The basic piston ring used in reciprocating service is the split rectangular section shown in Figure 1. Obtaining contact between the sealing surfaces depends on the use of a separate spring, such as a wave washer, or on the action of fluid pressure on the side of the ring. The low friction of TEFLON TFE resins produces a seal against the ring land quicker and at lower pressures than with other ring materials. Various piston-ring joints and multi-piece ring designs have been developed to improve ring sealability. Where wide temperature changes are not encountered and surface speeds are not high, it is not always necessary to split floating rings of TEFLON TFE resins. Since these rings are more resilient than other ring materials, they may be snapped into the groove and compressed into the cylinder upon installation, permitting additional cost savings in mass-production operations. They are available in virtually all sizes.

Life and wear of reinforced TEFLON TFE resins

Ring performance can be greatly improved by increasing the mechanical strength, resistance to wear, dimensional stability and thermal conductivity of these rings by reinforcing the TEFLON TFE resins. Several techniques for reinforcing TFE resins include: filled compositions (both particles and fibers), glass-fabric-reinforced, and metal-reinforced. All these constructions can be tailored to meet specific needs of pressure and velocity. The life and wear rate of piston rings of reinforced TFE resins depend, of course, on a variety of factors. It has been found, however, that reinforced TFE resins are superior to many of the best piston-ring materials used under extreme conditions. It is interesting to note that less wear is experienced using rings of TFE resins with cast-iron or stainless-steel bores than with dense chromium-plated bores. This suggests further opportunities for cost savings.

FOR MORE INFORMATION...

Further details on the properties and design characteristics of TEFLON TFE resins and their application to floating rings may be obtained from your local supplier. Look for him under "Plastics—Du Pont" in the Yellow Pages, or write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-3612, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

DU PONT TEFLON®
REG. U.S. PAT. OFF.
TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

in. below surface of interest for max response or at 0.002 in. below surface where abrasion is a consideration. **Advanced Technology Laboratories, 369 Whisman Rd, Mountain View, Calif.**

Circle 331 on Reader Service Card

Footswitch . . .

action can be maintained or momentary. Tapers from 2¼ in. rear of pedal to 3½ in. front for foot rest. 4½ in. long x 1⅞ in. high max. **Vemaline Products Co, PO Box 222, Hawthorne, NJ.**

Circle 332 on Reader Service Card

Transistorized converters . . .

for dc to dc and dc to ac are said to eliminate brush replacement. Reported to replace dynamotors in military and commercial equipment at about half the weight. Converter cools with built-in ac blower. Measures 8⅞ x 4⅛ in. dia. Weighs 7.75 lb. Input voltage is 22 to 30 v dc; input current, less than 25 amp. Output voltage is 1000 v dc; output current, 0.5 amp. Continuous-duty converters have operating range of −67 to 185 F under full load. **Daven Co, Livingston, NJ.**

Circle 333 on Reader Service Card

Pushbutton interval timer . . .

is totally enclosed. Timing interval can be factory or manually set to selected interval. At completion of interval, switch opens, de-energizing load and timing motor. UL-approved unit is rated 28 amp or 1 hp at 250 v ac. Available for 120 or 240 v operation, 50 or 60 cps, with any interval from 2 sec to 120 min. **Haydon Div, General Time Corp, 245 E Elm St, Torrington, Conn.**

Circle 334 on Reader Service Card

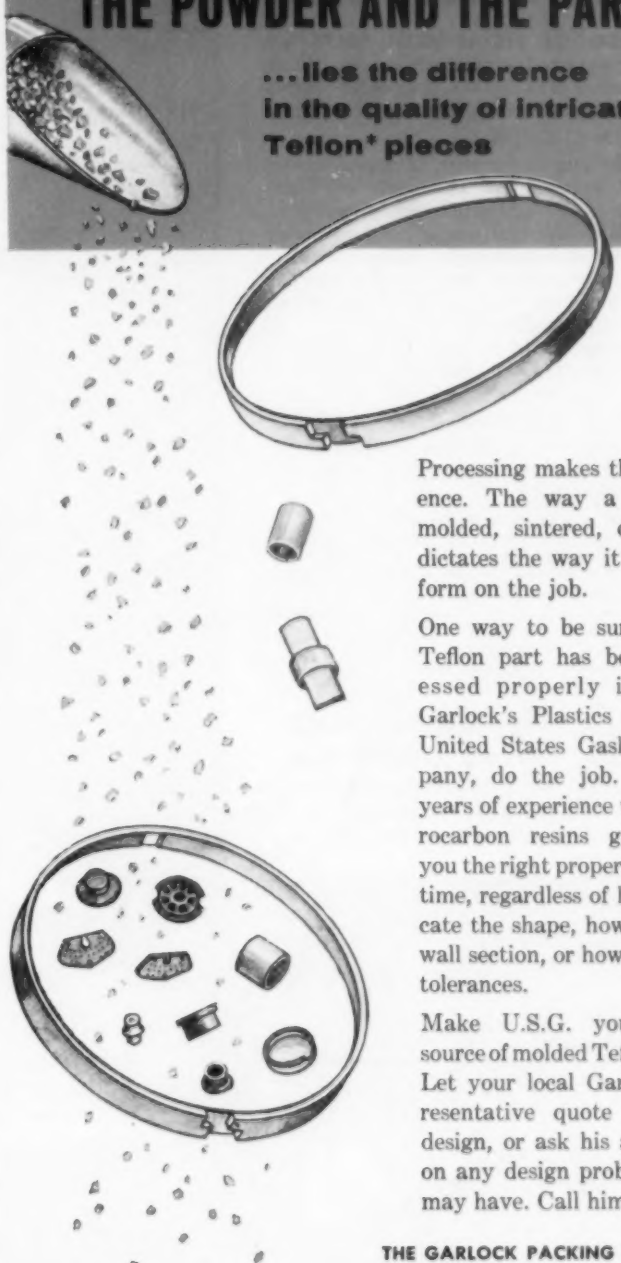
Sealed plug-in limit switch . . .

utilizes basic housing and mechanism of heavy-duty machine tool limit switches.

(Continued on page 111)

SOMEWHERE BETWEEN
THE POWDER AND THE PART...

...lies the difference
in the quality of intricate
Teflon* pieces



Processing makes this difference. The way a piece is molded, sintered, or cooled dictates the way it will perform on the job.

One way to be sure that a Teflon part has been processed properly is to let Garlock's Plastics Division, United States Gasket Company, do the job. U.S.G.'s years of experience with fluorocarbon resins guarantees you the right properties every time, regardless of how intricate the shape, how thin the wall section, or how close the tolerances.

Make U.S.G. your prime source of molded Teflon parts. Let your local Garlock representative quote on your design, or ask his assistance on any design problems you may have. Call him, or write

THE GARLOCK PACKING COMPANY
Palmyra, N.Y.

For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

**DuPont Trademark for TFE Fluorocarbon Resin*

United States Gasket Plastics Division of GARLOCK

. . . FAST, UNIFORM PROCESSING — 1960 . . .

CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive 60's—tighter operating costs, higher production and consistent quality.

Continuous movement of foods, metal parts, ceramics or chemicals on Cambridge Belts through processing operations speeds production and eliminates costly manual handling. Open mesh construction allows heat, cold or liquids to flow through the belt and around the product for thorough, uniform treatment. Superior belt design and manufacturing techniques mean longer life, fewer repairs, lower operating costs.

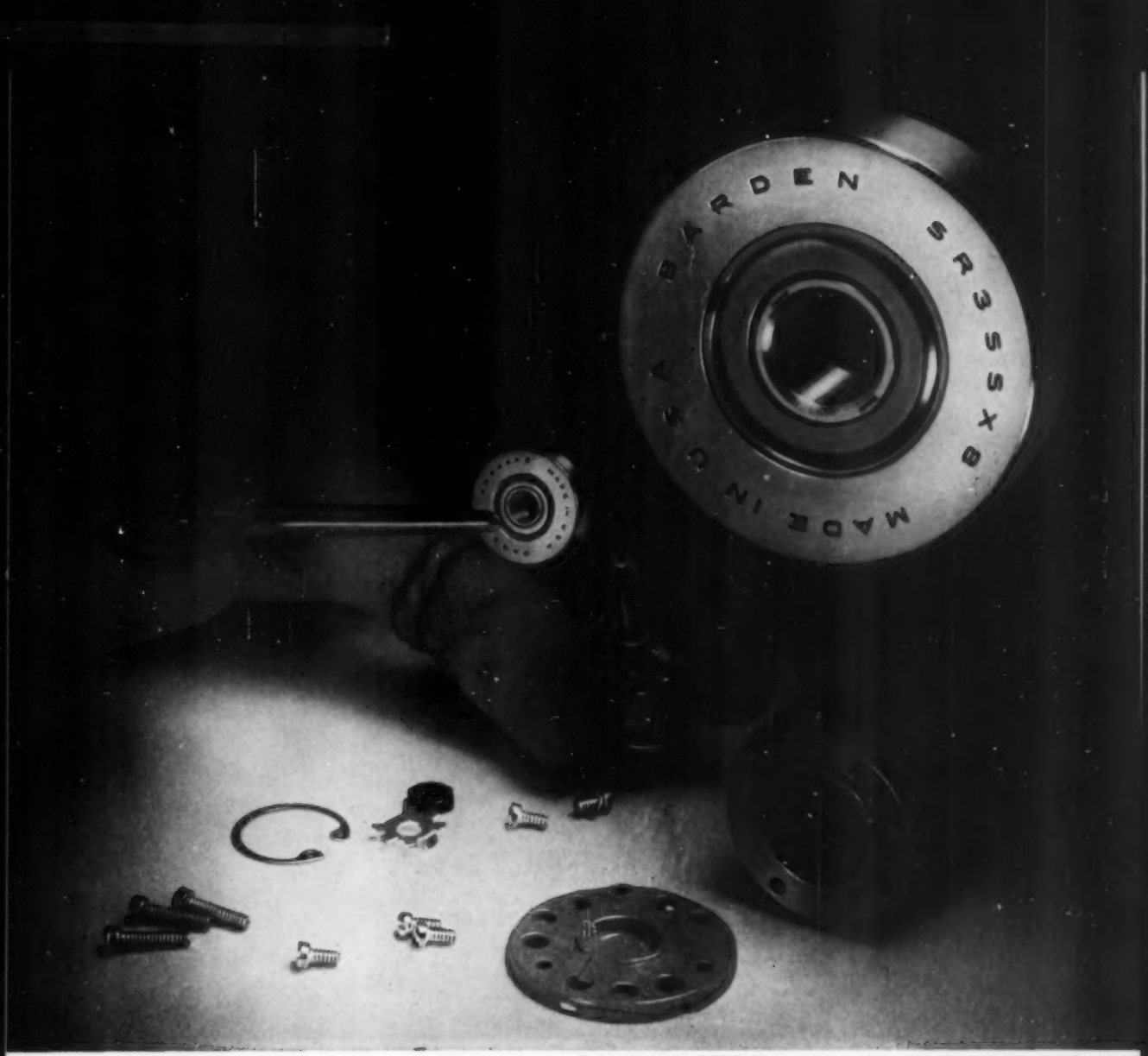
Belts can be made heatproof, coldproof or acidproof — in any mesh, weave, metal or alloy — with any side or surface attachments.

Whether you're designing machinery for your own use, or for resale, the Cambridge Field Engineer in your area will be glad to discuss the many advantages of Cambridge Belts — from manufacturing to installation and service. Call him today. He's listed in the yellow pages under "Belting, Mechanical". Or, write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.

Department P • Cambridge 12, Md.

Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications



Barden Precision SR3SSX8 bearings as used in a synchro transmitter/receiver.

BARDEN *functional testing assures precision performance*

The SmoothRator, an electronic performance tester, was developed by Barden to check vibration as a measure of overall functional quality. A standard quality control instrument at Barden, the SmoothRator is also used by many leading component and systems manufacturers.

Precision-built synchros require small, uniform air gaps and consistently low torque to provide accurate response to a generated signal.

Barden Precision low torque bearings assure the required air gap by close control of radial play and concentricity. The SR3SSX8 has an extra large O.D. which eliminates the need for end caps, increasing air gap accuracy and reducing synchro complexity and cost.

From research and design, through quality controlled production, functional testing and application engineering each *Barden Precision* bearing is planned for performance. *Barden Precision* means not only dimensional accuracy but performance to match the demands of the application.

Barden Precision bearings must pass rigid functional tests on the SmoothRator, the Torkintegrator and other Barden-developed or standard test devices. This functional testing is your assurance of consistent precision performance.

Your product needs *Barden Precision* if it has critical requirements for accuracy, torque, vibration, temperature or high speed. For less difficult applications, Barden *predictable* performance can cut your rejection rates and teardown costs.

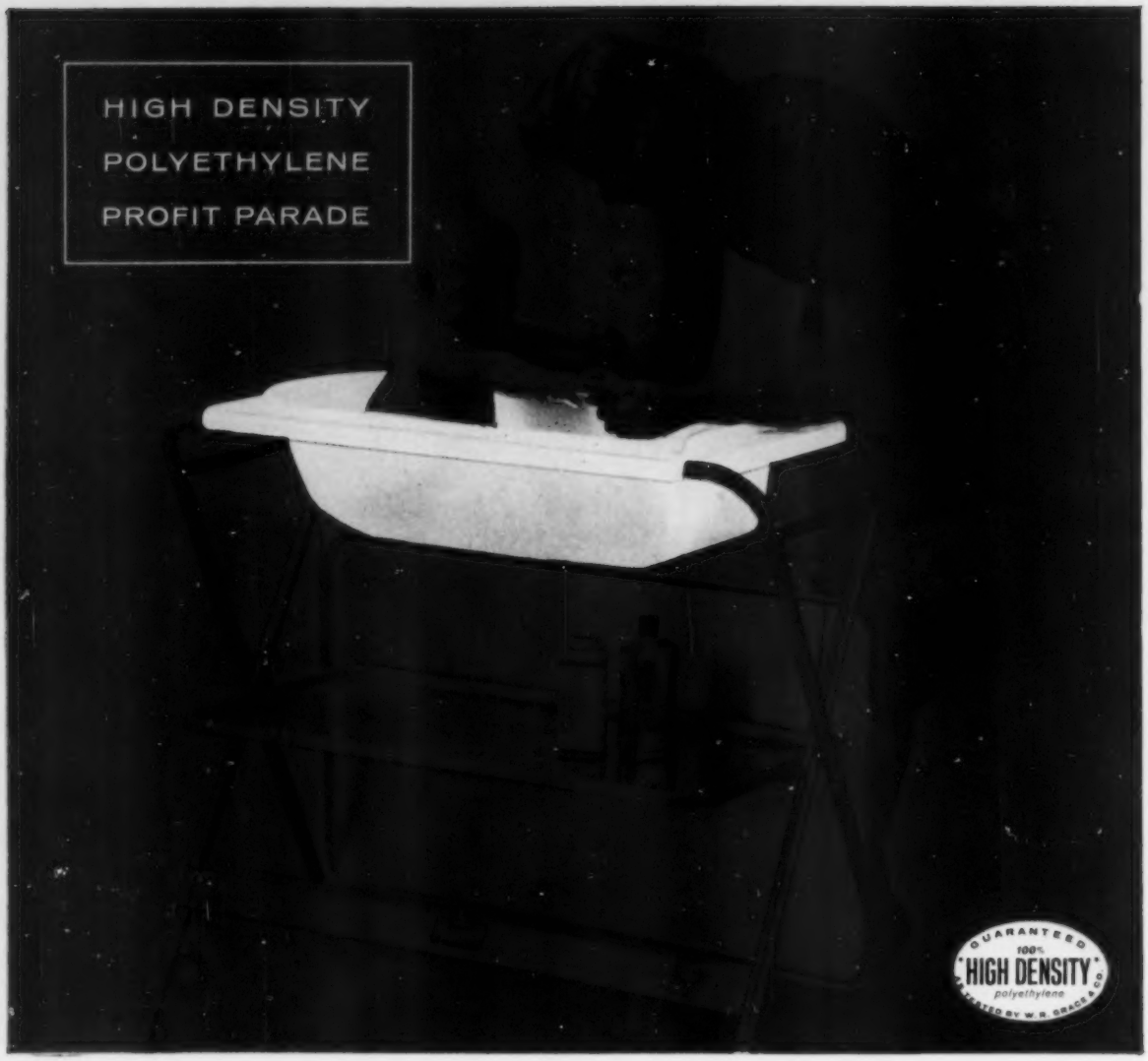
THE BARDEN CORPORATION

212 Park Avenue, Danbury, Connecticut

Western office: 3880 Wilshire Boulevard, Los Angeles 5, California

SPECIFY BARDEN PRECISION BALL BEARINGS FOR: INSTRUMENTS • AIRCRAFT ACCESSORIES • COMPUTERS AND RECORDERS • MACHINE TOOL AND TEXTILE SPINDLES • OTHER PRECISION APPLICATIONS

CIRCLE 109 ON READER SERVICE CARD



Exclusive Selling Advantages Offered in Lifetime Tub

Products in many different fields are gaining an edge over competition by utilizing the benefits of Grex high density polyethylene. The "Lifetime Tub" by Baby Bathinette Corporation is an example that really holds water.

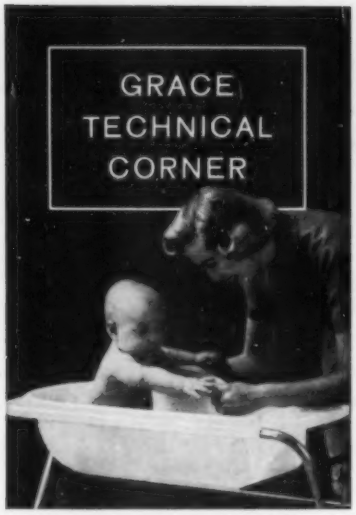
This well-known manufacturer chose Grex to make a tub that would outlast competitive models since this is a tough plastic that is virtually indestructible. They used its molding characteristics to obtain a soft, pleasant, easy-to-clean texture. They took advantage of its strength and rigidity to make the tub light in weight for greater ease of carrying.

This new Grace plastic offers a unique combination of properties to help you create unique selling advantages. It takes a beating without chipping, cracking or breaking. It can be molded in any color and decorated. It resists the elements and most corrosive chemicals. And it is the only thermoplastic that takes boiling or freezing without losing its shape or strength.

If you need an idea of how to gain an edge over competition by using high density polyethylene be sure to call in the experts. Grace has the production facilities, technical service and experience to help put your product in the Grex profit parade. We're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION CLIFTON, NEW JERSEY



Grex answers design and molding problems on extra-large piece.

Don't let size limit your thinking when designing or molding with Grex high density polyethylene. The "Lifetime Tub" shown here is 30½" x 6½" x 19"—one of the largest pieces so far injection molded with this Grace plastic. Some of the technical thinking that went into this job may give you an idea of how to get the most from Grex.

Cost a design factor. Production of a piece as large as this tub invariably presents a cost problem. Taking advantage of the way Grex performs in thin wall sections, the designers were able to keep the amount of resin per tub to a minimum and permit economical cycle times. Use of thin walls, however, called for a design that would not only take care of the weight of baby and water but also provide for satisfactory suspension of the tub in its metal frame. Reverse curves solved both problems and minimized use of ribs and fillets to avoid heavy sections, sinks and depressions.

Mold surface. Depending on mold surface, Grex takes any finish ranging from high gloss to matte. In this case, it provided a smooth, pleasant texture—essential to protect baby and make cleaning easy—through the use of a highly polished chrome-plated mold.

Molding technique. Production of the tub involved a 3-pound shot of Grex, a large mold cavity and thin wall sections. Under these conditions, multigating was chosen over normal gating. With four gates the cavity was filled faster and strain reduced.

What are your problems? If you have a job in mind for high density polyethylene count on Grace for help. Now's the time to call, wire or write:

Technical Service Department,
Polymer Chemicals Division,
W. R. Grace & Co., Clifton, N. J.

Available in styles that will plug-in in line with length of switch or at right angles. **R B Denison Mfg Co, 386 Broadway, Bedford, Ohio.**

Circle 335 on Reader Service Card

Low-capacity flow meters . . .

are available with or without built-in control valve. Metering tubes and floats cover flow range of 0.01 to 30 gph of water; or 0.12 to 125 scfh of air. Glass metering tubes are either 3 or 1½ in. scale, direct-reading. Applicable in purge, liquid level control or other uses. **Wallace & Tiernan Inc, 25 Main St, Belleville 9, NJ.**

Circle 336 on Reader Service Card

Ac or dc midget solenoid . . .

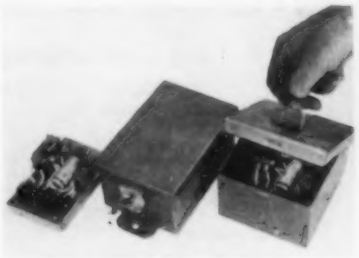
for intermittent or continuous duty, has tapered plug and plunger. Plunger strokes range from $\frac{1}{16}$ to $\frac{1}{2}$ in. with lift of over 41 oz. Over-all dimensions are $1\frac{1}{8}$ x 1 x $1\frac{5}{16}$ in. Weighs about $3\frac{1}{2}$ oz. **Guardian Electric Mfg Co, 1621 W Walnut St, Chicago 12.**

Circle 337 on Reader Service Card

Carbon, low-alloy, stainless . . .

steel tubing in square, rectangular and special shapes is now available over a range of sizes. Formed from round tube stock. Round tube dimensions range from $\frac{3}{8}$ to 6 in. OD with wall thicknesses of 0.028 to 0.250 in. for carbon and low-alloy steel; from $\frac{3}{8}$ to $4\frac{1}{4}$ in. OD with wall thicknesses of 0.028 to 0.165 in. for stainless steel. **Standard Tube Co, 24400 Plymouth Rd, Detroit 39.**

Circle 338 on Reader Service Card



Pulse controller . . .

extends or shortens time-length of electric impulse. Available from stock in three adjustable ranges, 30 to 500 millisec. Provides output pulse of up to 5 amp at 115 v ac. Can be recharged in 15 millisec and lag from start of input to start of output pulse is 5 millisec. For application with hydraulic-pneumatic machinery, counters or wherever it is desirable to adjust length of electrical impulse. **Warco Industries Inc, 6625 Delmar Blvd, St. Louis.**

Where strength is a factor

HOT FORMED NUTS

. . . Induction heated

Through induction heating and modern forming equipment, these Screw and Bolt nuts attain superior finish, wrenching qualities and tolerances.

The instant heating process eliminates cold working strains prevalent in conventional cold made nuts, minimizing oxidation. Then modern equipment forms these nuts to geometric perfection and exceptionally close tolerances . . . for secure, snug-fitting connections.

When rugged operating conditions exist, be sure . . . specify hot formed nuts by Screw and Bolt. Send for illustrated brochure. VMA 6733

SCREW AND BOLT CORPORATION OF AMERICA P.O. Box 1708 Pittsburgh 30, Pa.

Formerly Pittsburgh Screw and Bolt Corporation

America's Most Complete Line of Industrial Fasteners

CIRCLE 111 ON READER SERVICE CARD

IN Synthe-Seal® BEARINGS

MARLIN-ROCKWELL RELIABILITY COUNTS

MRC Synthe-Seal® bearings have a long record of satisfactory performance in thousands of applications including extreme conditions of dirt and moisture.

MRC Synthe-Seal® BALL BEARINGS HAVE THESE IMPORTANT ADVANTAGES:

- Flexible synthetic rubber seal is bonded to steel core for strength
- Synthe-Seal® resists operating pressures
- Seal drag is controlled to give low torque with less power required
- Produce economy by eliminating maintenance time
- Reliability provided by elimination of down time
- Operating range from — 80° F. to + 225° F.
- Manufactured to standard AFBMA dimensions and tolerances
- MRC Synthe-Seal® bearings are backed by 62 years experience in manufacturing ball bearings

Send for FORM 1528 listing sizes available

Marlin-Rockwell Corporation
Jamestown, N. Y.

MRC
BALL AND ROLLER *bearings*

INNERCORES! Pick your metal: brass, 356 alloy bronze, 48% nickel alloy steel, monel, stainless steely other alloys. Seamed or seamless, name the properties you need and ask TITEFLEX. **Remember, we manufacture it.**

freedom of design with **titeflex** flexible metal hose

BRAIDING! Round wire for maximum flexibility, flat ribbon for high pressures and maximum abrasion resistance. **Metals:** silicon-bronze, nickel, AISI-321 stainless, copper clad steel. **Remember, we manufacture it.**

FITTINGS! Guaranteed against blow-off at specified range of temperatures and pressures. TITEFLEX engineering makes the fitting virtually part of the hose. Assemblies of any length. **Remember, we manufacture it.**

It's lighter!
It's more flexible!

It has a smaller bending radius than most competitive hose. Yet TITEFLEX quality is so perfectly controlled that its features meet or surpass the really tough specifications. And TITEFLEX flexible metal hose is available with innercores and braid of many superior metals and alloys to match your needs.

Get more freedom in your designs . . . where fluids are carried between connecting parts of equipment or machinery . . . between misaligned parts . . . where you wish to absorb vibration . . . or to simplify multiple bend situations.

TITEFLEX engineers can help you no matter what you demand in flexibility, operating temperatures, fluid media, or pressure ratings. Ask your TITEFLEX distributor in the Yellow Pages, or write direct.

titeflex

from end to end, inside and out, made right in our own plant

titeflex inc. springfield mass. PACIFIC DIVISION • SANTA MONICA • CALIFORNIA

CIRCLE 113 ON READER SERVICE CARD 113

CASH-ACME . . . meeting pressure control needs for product design engineers everywhere
Type Vacuum Regulator Valve D-51
CASH-ACME VACUUM REGULATOR VALVE PREVENTS CIGARETTE JAM IN NEW FILTER TIPPING DEVICE

To keep pace with fantastic demands for filter tipped cigarettes (now 40% of the market), manufacturers are attaching a new kind of tipping device to machines —capable of tipping 780,000 cigarettes in a 10-hour run

Designers give a lot of credit for the device's amazingly foolproof performance to Cash-Acme engineers An extremely exact "low whisper" vacuum must be maintained at all times... just enough to hold the cigarette while the filter is affixed. This is assured by strategic placing of Cash-Acme Regulator Valve D-51 on the machine's vacuum line which brings high vacuum from the plant's central system. By regulating and keeping the vacuum at the proper level, all chances of "jamming" and production loss are eliminated.

TYPE D-51 VACUUM REGULATING VALVE Ready for exacting vacuum regulating jobs on any type of equipment. Type D-51 is expressly designed for use in systems where it is desired to maintain, automatically, a lower vacuum at the valve inlet than prevails at the source on the valve outlet. No step-action, no snap-action, but full-floating and automatic.

A. W. CASH VALVE MFG. CORP.
6627 East Wabash Ave., Decatur, Ill.

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 128

WIRE AND STRIP COMPONENTS—Handbook, 22 pp. Offers case studies of uses of wire and strip metal components. Describes major types of wire available, finishes, wire sizes and end treatments, threading and forming possible. E H Titchener & Co, Custom Design Dept, 57 Clinton St, Binghamton, NY.
Circle 340 on Reader Service Card

METAL ENGINE FASTENERS—Catalog 111, 50 pp. Covers engine nuts made for temperatures to 1400 F and —350 F. Discusses fabrication, self-locking principle and includes chemical analysis and strength comparison of engine nut materials. Kaynar Mfg Co Inc, Box 2001, Terminal Annex, Los Angeles 54.
Circle 341 on Reader Service Card

FLUID-POWER EQUIPMENT – Bulletin 10051-H, 16 pp. Includes specifications, illustrations, references and descriptions of pumps, motors, transmissions, servo components, cylinders and valves. Oilgear Co, 1570V W Pierce St, Milwaukee 4.
Circle 342 on Reader Service Card

PRECISION BALLS – Catalog, 16 pp. Contains new AFBMA bearing ball standards, cross-referenced to standards dated July 1956, and master table of ball grades and tolerances. Information covers material characteristics, mechanical properties, resistance factors, machinability, hardness, size, weight and quantities per lb. Hartford Steel Ball Co, 12 Jefferson Ave, West Hartford, Conn.
Circle 343 on Reader Service Card

CIRCULAR HOSE CLAMPS—Bulletin CC, 5 data sheets. Covers descriptions and specifications of fittings, regular and heavy-duty service clamps, ladder lug clamp, and clamps for low-pressure applications. Also describes and illustrates installation tools. Circle Clamp Div, Cuyahoga Products Corp, 10252 Berea Rd, Cleveland 2.
Circle 344 on Reader Service Card

PLANETARY AND STAR GEARS—Bulletin 2401, 8 pp. Construction details, capacity and selection curves, selection examples, tables of dimensions and cutaway drawings for eight sizes. De Laval Steam Turbine Co, Trenton, NJ.
Circle 345 on Reader Service Card

ALUMINUM EXTRUSIONS—Brochure 5909, 12 pp. Describes aluminum extrusion process and available aluminum alloys, with information on mechanical properties, recommended uses and reference numbers. Basic extrusion types are illustrated and discussed, along with standard tolerance and pricing factors. Precision Extrusions Inc, Green St, Bensenville, Ill.
Circle 346 on Reader Service Card

PRECISION POTENTIOMETERS – General catalog, 18 pp. Cover facilities and services, followed by about 100 data sheets on specific products. Data sheets include descriptions, specifications, ratings and dimensional drawings. Technology Instrument Corp, 531 Main St, Acton, Mass.
Circle 347 on Reader Service Card

DIODES AND CAPACITORS—Catalog USS 8-59, 8 pp. Gives brief descriptions, IN numbers and basic specifications of semiconductor and tantalum capacitor line. US Semiconductor Products, Div of Topp Industries Inc, 3540 W Osborn Rd, Phoenix, Ariz.
Circle 348 on Reader Service Card

STANDARD METAL HOUSINGS—Catalog 600, 20 pp. Features line of modular console systems. Also presents chassis, cabinets, racks and panels for electronic applications. Premier Metal Products Co, 337 Manida St, New York 59.
Circle 349 on Reader Service Card

SWITCHING TRANSISTORS—Booklet, 24 pp. Lists max ratings and electrical characteristics of medium and high speed switching transistors. Also contains nine transistor switching time measurement circuits, diagrams illustrating mechanical specifications and connections, and a section on transistor switching time requirements. Sylvania Electric Products Inc, 1100 Main St, Buffalo 9.
Circle 350 on Reader Service Card

ALUMINUM ELECTRICAL STRIP CONDUCTOR—Data sheets 11c, 14 pp. Product description section discusses product and production techniques; availability section defines standard items, manufacturing limits, quantities, shipping tolerances and standard packaging procedures; specifications section lists chemical com-

(Continued on page 118)

Miniature Directional Signal. A foraging bee brings home one drop of nectar. His fellow workers sniff it like bloodhounds, and from the scent know just where to go for more. This tiny droplet is nature's miracle for keeping bees on the beam.

Miniature Selector Switch. Missiles stay on course when controlled by complex selector switch. Two MPB bearings on its shaft make frictional torque practically negligible, keep total weight down to .42 ounce. It's a man-miracle in miniaturization.

Man With Miracles. This is Hank Eckert, one of MPB's Sales Engineers. He helped the selector switch people find exactly the right type of MPB radial retainer bearing to hold friction to a minimum, give dependable service and assure operating precision.

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BEARING ACTUAL SIZE

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MPB makes miniature bearings $\frac{3}{16}$" O.D. *down* (specials on request). In stock—over 500 types and sizes. Consult MPB when you are embarking on a miniaturization problem and/or write for new MPB catalog. **Miniature Precision Bearings, Inc.,** 213 Precision Park, Keene, N. H.

MPB

Helps you perform miracles in miniaturization

CIRCLE 115 ON READER SERVICE CARD 115

DOW | METAL PRODUCTS

PRECISION MAGNESIUM EXTRUSIONS (inset) form two key parts for hydraulic paper cutter.

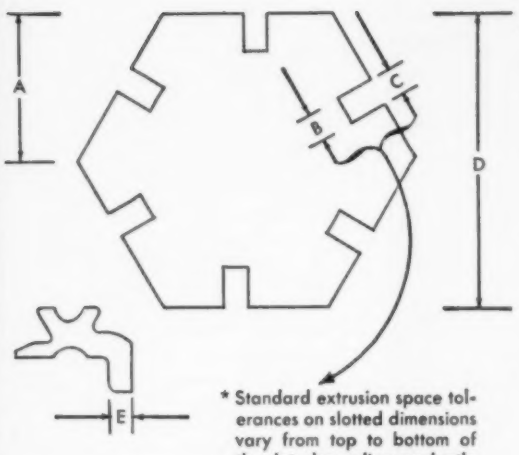
PRECISION EXTRUSIONS

tighten tolerances, cut costs

Paper cutter manufacturer slices production costs by replacing all-milled components with magnesium precision extrusions boasting tolerances as close as ± 0.0025.

Precision magnesium extrusions—a recent development of Dow's Madison, Illinois plant, deliver a big assist in the design of parts that must be extremely accurate and dimensionally stable. A wide variety of precision parts can be extruded with substantial savings in scrap loss, machining and setup time.

Harris-Seybold Company, a division of Harris Intertype Corporation, puts these advantages to work in the manufacture of hydraulic paper cutting machines. Results: six different machining and allied operations eliminated . . . machining and setup time for two key parts reduced by 64% and



* Standard extrusion space tolerances on slotted dimensions vary from top to bottom of the slot, depending on depth.

TOLERANCES HELD ON PRECISION MAGNESIUM EXTRUSIONS

Critical Dimension	Standard Extrusion Tolerance	Precision Extrusion Tolerance
A	± 0.012	± 0.0025
B*	± 0.007	+ 0.003 − 0.000
C*	± 0.012	+ 0.003 − 0.000
D	± 0.024	± 0.005
E	± 0.007	+ 0.000 − 0.003

78%. Basic material costs were also lowered. The metal previously used was supplied in a high-property alloy in order to minimize warpage during the extensive machining operations. The standard magnesium alloy now used costs less. In addition, straightening operations required with the previous metal are no longer necessary.

The two parts Harris-Seybold now buys as precision magnesium extrusions serve to position the paper correctly for a number of successive cuts. They range from 46 to 106 inches in length and must be both dimensionally accurate and free of kinks and bows. No machining of these extruded parts is required after they are received in the Harris-Seybold plant.

For facts and figures about precision magnesium extrusions as they apply to your requirements, write to THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Sales Department 1341DZ-12-7.

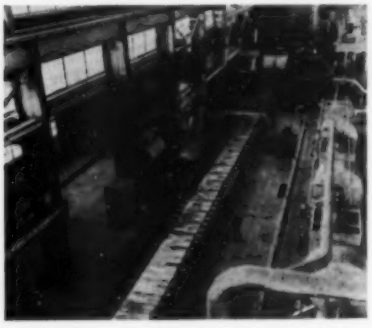
HOW MAGNESIUM PRECISION EXTRUSIONS CUT SETUP AND MACHINING TIME

PART AND MATERIAL	OPERATIONS REQUIRED	TOTAL SETUP & MACHINING TIME
Spacer Bar:		*10 pieces per production run*
Previous Metal	8	1,750 minutes
Magnesium Precision Extrusion	5	626 minutes
Stop Carrier Strip:		*60 pieces per production run*
Previous Metal	8	2,399 minutes
Magnesium Precision Extrusion	5	510 minutes

OPERATIONS ELIMINATED BY MAGNESIUM PRECISION EXTRUSIONS

Spacer Bar	Stop Carrier Strip
1. Straightening	1. Straightening
2. Milling slots	2. Milling critical dimension
3. Burring slots	3. Straightening

GIANT EXTRUSION PRESS, largest used to extrude magnesium, produces sections up to 30-inch circumscribed circle. This 13,200 ton press extrudes large structural shapes of magnesium and aluminum for aircraft and missile parts, other applications.



ROLLING MILL at Madison, Illinois is the largest in the world for magnesium alloys. Flat sheet and plate and coiled sheet are produced in a wide range of sizes. Extra flat tooling plate for all tooling uses is also produced at this plant.

THE DOW METAL PRODUCTS COMPANY, Midland, Michigan

A Division of The Dow Chemical Company

CIRCLE 117 ON READER SERVICE CARD 117

Well established in special nuclear applications, BERYLLIUM METAL is now being used and tested for structural components in other industries.

High strength to weight ratio • good high temperature properties • high modulus • excellent heat sink characteristics make this light metal attractive for current and future design.

Availability has improved—in quantity and mill forms—fabrication sources are increasing rapidly.

Let us send our latest literature—technical sales service available. Keep abreast of latest developments with the growing use of BERYLLIUM through . . .

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READING, PENNSYLVANIA

Write to SALES ENGINEERING—BERYLLIUM METAL DEPT. for latest literature.

position limits, electrical and anodic film properties and describes preshipment tests. Reynolds Metals Co, Richmond 18, Va.
Circle 351 on Reader Service Card

PRECISION RESISTOR WIRE—Brochure, 12 pp. Presents graphic evaluation of physical and electrical properties required for use in precision wire wound resistors and potentiometers and properties and characteristics of low density-high resistivity Alloy 815-R. Includes specification tables. Hoskins Mfg Co, 4445 Lawton Ave, Detroit 8.
Circle 352 on Reader Service Card

RC RELAY CONTACT PROTECTORS—Bulletin, 8 pp. Covers construction, properties and specifications of protectors, followed by general discussion of problem of arc suppression. Presin Co, 2014 Broadway, Santa Monica, Calif.
Circle 353 on Reader Service Card

ELECTRONIC TIME DELAY RELAYS—Bulletin 376-100REV, 8 pp. Presents characteristics, operation principles, and dimensions of 18 standard units. Master Specialties Co, 956 E 108th St, Los Angeles 59.
Circle 354 on Reader Service Card

HEAVY-DUTY MINIATURE POWER CONNECTORS—Catalog 1416, 12 pp. Specifications, outline dimensions, illustrations and descriptions of series 14, 16, EZ and GA rectangular power connectors. De-Jur Amsco Corp, 45-01 Northern Blvd, Long Island City 1, NY.
Circle 355 on Reader Service Card

INTERCHANGEABLE DIESEL AND CARBURETED ENGINES — Catalog CR-608-I, 12 pp. Describes 75 and 95 max hp engines. Each pair of carbureted and diesel engines is interchangeable in power and dimenisons. International Harvester Co, 180 N Michigan Ave, Chicago 1.
Circle 356 on Reader Service Card

BEARING ALUMINUM BARS — Brochure, 12 pp. Presents chemical analysis, mechanical properties, characteristics and information on machining of bars. Dimensions are tabulated. Bunting Brass and Bronze Co, 715-755 Spencer St, Toledo 1, Ohio.
Circle 357 on Reader Service Card

INSULATORS—Catalog, 4 pp. Dimensions, physical and electrical properties and prices for line of glass fiber reinforced polyester electric insulators. Glastic Corp, 4321 Glenridge Rd, Cleveland 21.
Circle 358 on Reader Service Card

MOISTURE AND CORROSION INHIBITOR—Bulletin, 6 pp. Discusses
(Continued on page 123)

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON

RIVETORS · SIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

CIRCLE 119 ON READER SERVICE CARD

News and Notes on...

Good Packing Practice

JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Selecting the Gasket

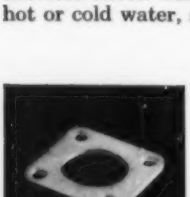
Question:

What are the important points to remember about gasket applications so we can avoid costly failure?

GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

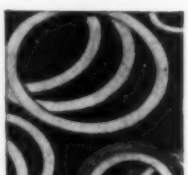
Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

For service at low to medium temperatures and pressures: As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



If corrosive fluids are encountered: The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow (glass-filled) Teflon, Teflon-Asbestos, and in metal-Teflon combinations.

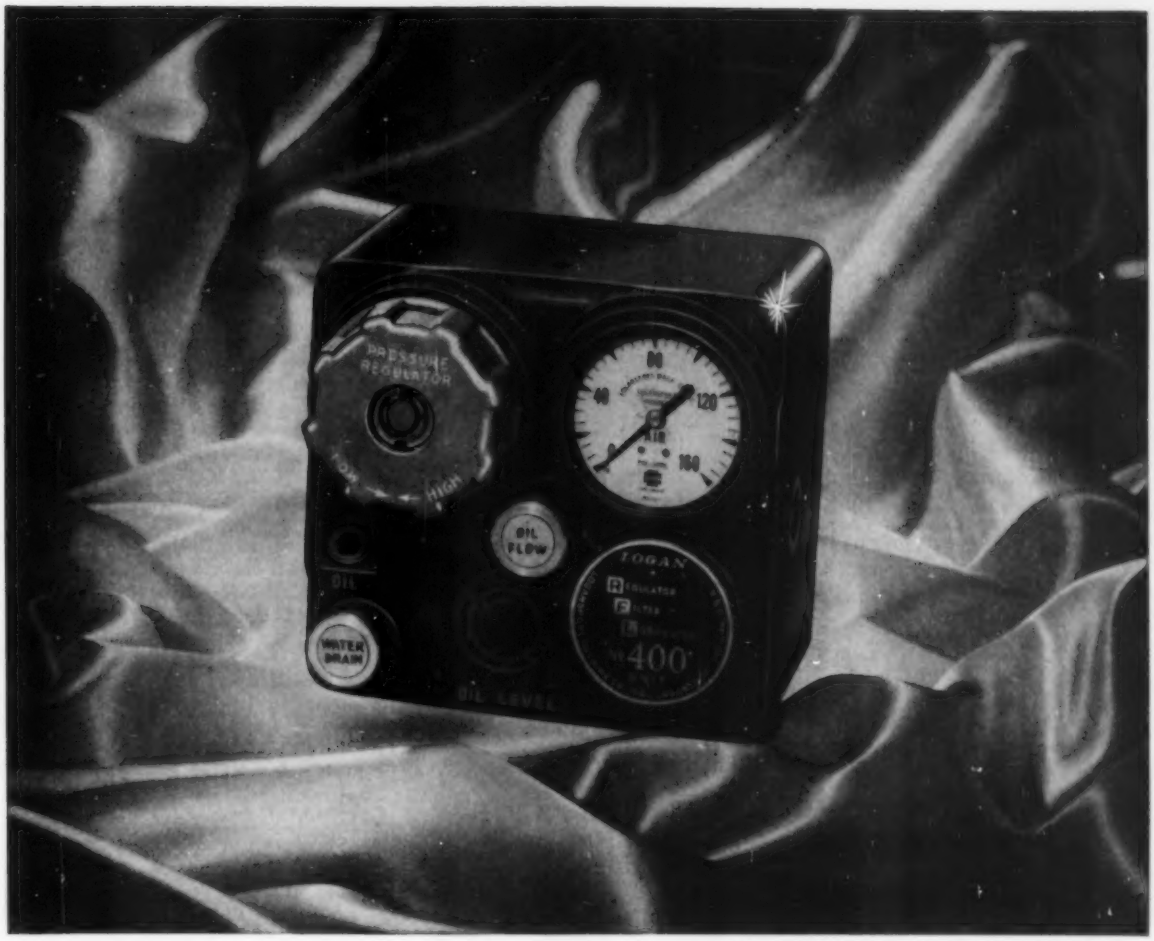
*TM for DuPont Tetrafluorethylene resin.



When extreme pressures and temperatures act on the gasket: If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE



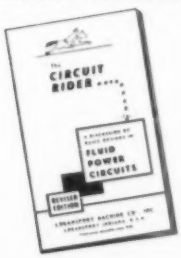
Illustrated—Logan Model 400 RFL Unit

Look to Logan

the ultimate in air circuit accessories

Logan RFL Unit, the designers choice for over a decade! Protects your air-powered equipment . . . regulates pressure . . . filters air . . . lubricates air. Adds years of dependable performance.

New Model 400, illustrated above, is a companion model to the well-known Model 600.



FREE **SEND FOR YOUR COPY OF THE LOGAN "CIRCUIT RIDER" A 32-page manual on fluid power circuits (fifth edition) completely revised to present current engineering trends.**

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

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812 CENTER AVENUE, LOGANSPORT, INDIANA

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- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
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- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
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Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66DD.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet • Screw
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CIRCLE 122 ON READER SERVICE CARD

SCHNORR Disc Springs

Outlast Others...

Creeping, initial settling and gradual fatigue are eliminated when you use SCHNORR Disc Springs. Under normal loads, they provide *unlimited life.*

SCHNORR Disc Springs offer other advantages.

- **Exact adjustment.** One size provides different pressures and deflections, insures exact adjustment to the desired pressure. Spring pressure, length and deflection are easily altered for the same spring size by lengthening, shortening or multiple stacking the spring columns.
- **Space-saving.** Power concentration in small space.
- **Great shock absorption,** minimal after oscillation. A large degree of inherent and impact damping assured.

For reduction in noise and play in ball bearings, consider SCHNORR Disc Springs "K" (not shown).

Most sizes available from stock.

FREE! Get data on SCHNORR Disc Springs. Write today.

Sole Representative
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Dept. PE-129, 404 4th Ave.
New York 16, N. Y.

NEISE MODERNTOOLS

CIRCLE 204 ON READER SERVICE CARD

Have you stopped learning?

A British statesman, it is said, read Gibbons "Decline and Fall of the Roman Empire" while waiting for his wife to dress for dinner.

Once a man feels the urgency to learn, it's remarkable how he finds the time and place to do it.

If he had to spend countless hours seeking out that which would be most useful in his work, the going might be rough. But, happily, this herculean task has already been accomplished by McGraw-Hill specialized magazines that span almost every field and function.

Your very own publication, for instance, that you are reading right now. Read it inquisitively. Read it imaginatively. Pass it along to your fellows, tell them how much they can get out of it, too . . .

Men who read more...earn more!

characteristics of coating for electrical and electronic equipment, how it works, methods of application and includes specifications. Corrosion Reaction Consultants Inc, 116 Chestnut St, Philadelphia 6.

Circle 359 on Reader Service Card

TEMPERATURE CONVERSION – Wall chart. Converts Fahrenheit to Centrigrade and vice-versa; gives interpolation factors for fractional readings. Reverse side of chart gives differences between wet and dry bulb temperatures for determination of relative humidity. Electric Hotpack Co Inc, Dept 40, Cottman and Melrose, Philadelphia 35.

Circle 360 on Reader Service Card

COLD-FINISHED CARBON STEEL BARS–Bulletin 12-5, 4 pp. Revised to include information on additional types of leaded steel bars. Stock sizes and shapes of more than 20 different kinds are shown, along with information on strength, workability, machinability, heat treatment and cost. Jos T Ryerson & Son Inc, Box 8000-A, Chicago 80.

Circle 361 on Reader Service Card

ROTARY GEAR PUMPS–Bulletin 42, 4 pp. Explains design features and presents tables of dimensions, capacities (¼ to 146 gpm), hp ratings, pressures and rpm. Northern Ordnance Inc, Minneapolis 21.

Circle 362 on Reader Service Card

TUBE FITTINGS–Folder 4306B1, 4 pp. Offers condensed selection information. Includes shape charts for six types of industrial tube fittings and illustrations of tube-working tools. Parker Fittings & Hose Div, Parker-Hannifin Corp, 17325 Euclid Ave, Cleveland 12.

Circle 363 on Reader Service Card

HEAVY-DUTY ROLLER BEARINGS–Catalog 359, 6 pp. Describes one-piece cage-design roller bearings, with information on design, ratings and installation. Torrington Co, Torrington, Conn.

Circle 364 on Reader Service Card

ADHESIVES–Booklet, 6 pp. Briefly describes various adhesives available for specific types of applications. Adhesive Products Corp, 1660 Boone Ave, New York 60.

Circle 365 on Reader Service Card

MEGACYCLE PULSE GENERATOR–Catalog sheet, 1 pp. Specifications for Model 3450C modular instrument. Electro-Pulse Inc, 11861 Teale St, Culver City, Calif.

Circle 366 on Reader Service Card

REPRODUCTION FILMS – Folder, 4 pp. Describes available reproduction

(Continued on page 126)

PART	COULD BE	REALLY IS
	Chemical resistant tool for scraping bottom of the barrel.	Silicone gasketing for high temperature industrial oven.
	Tip for pogo stick used by a faint-hearted fakir.	A chemical and temperature resistant bellows used in jet aircraft.
	Last word in wrapping for a red-hot mummy.	Special Silicone winding for an electric motor.
	Disguise for a half-masked refrigerator-raider.	Silicone gasket produced for the automotive industry.
	All-weather decoy for duck hunters.	Heat-resistant Silicone extrusion used for oven gasket.

8301-ER

Guessing games can be fun . . . but not with rubber parts! Silicone rubber parts by Stalwart assure you high strength, maximum stability and superior dielectric qualities at temperatures ranging from −160° to +600° F. And Stalwart is the only producer of extruded and calendered *Silicone sponge parts*. Stalwart also accurately produces parts from a complete range of natural and synthetic rubber compounds to meet individual operating requirements. Write for complete information.

NEW! Send today for your copy of the Stalwart catalog.

STALWART RUBBER COMPANY

166 Northfield Road
Bedford, Ohio
Manufacturing facilities in
Jasper, Georgia and Bedford, Ohio

CIRCLE 123 ON READER SERVICE CARD 123

MT. VERNON DIE CASTING ENABLES FOREMOST TO UNDERSELL ELECTRIC CAN-OPENER MARKET

CASE HISTORIES FROM MT. VERNON FILES

Subject:
Foremost Appliance Corp., BROOKLYN, NEW YORK

The big reason why this quality can-opener can sell for far less than all its competitors: it was designed expressly to simplify assembly by utilizing all of die casting's unique advantages—high strength-to-weight ratio, great flexibility of shape, inherent reproducibility, high production rate, clean finish and high degree of dimensional accuracy.

The result is an intricate integral casting that contains, among other details, bearing wells for motor drive shaft and reduction gears, along with bosses to mount the heavy-duty, high-speed motor and gear train. There are no bearing alignment problems, because the casting is extremely strong...able to hold critical tolerances despite its light weight and compactness.

The casting also contains bosses for back-panel mounting, recessed cam actuator channel, switch actuator guide pins, switch mounting guide, slots and perforations for the sliding face plate, front and bottom air vents, and switch-limiting post projecting from the trim, modern face. These rigid, rugged castings are supplied trimmed and machined, with switch slot and mounting holes already punched. 12 secondary assembly operations were thus eliminated from the prototype.

Mt. Vernon's experienced four-fold service helped solve Foremost's challenge in record time...an 11th hour challenge to have their product in stores in time for Christmas selling. First...designing the many cost-saving features into the casting—second, making the extremely intricate, extremely precise dies, with nameplate inserts—third, utilizing their huge, modern die-casting facilities for lower-cost quantity runs of more perfect castings—and fourth, complete machining facilities for on-time delivery of clean castings ready for baked-enamel finishing and assembly.

Mt. Vernon's coordinated four-fold services are under one roof—in 200,000 sq. ft. of space...ready to help you produce a finer product through the unique benefits only die-casting offers. A call to your nearest Mt. Vernon representative—for information or assistance at any phase—may also help you solve the problem of how to undersell your competitors. He'll be glad to talk it over. Call him today.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES

BALTIMORE, MD.: Mr. C. M. Gordan, 919 St. Paul St.
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CLEVELAND, OHIO: Mr. Grant Eller, 6 East 194th St.
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QUINCY, MASS.: Mr. Edmund W. Lilley, 91 Merrymount Rd.
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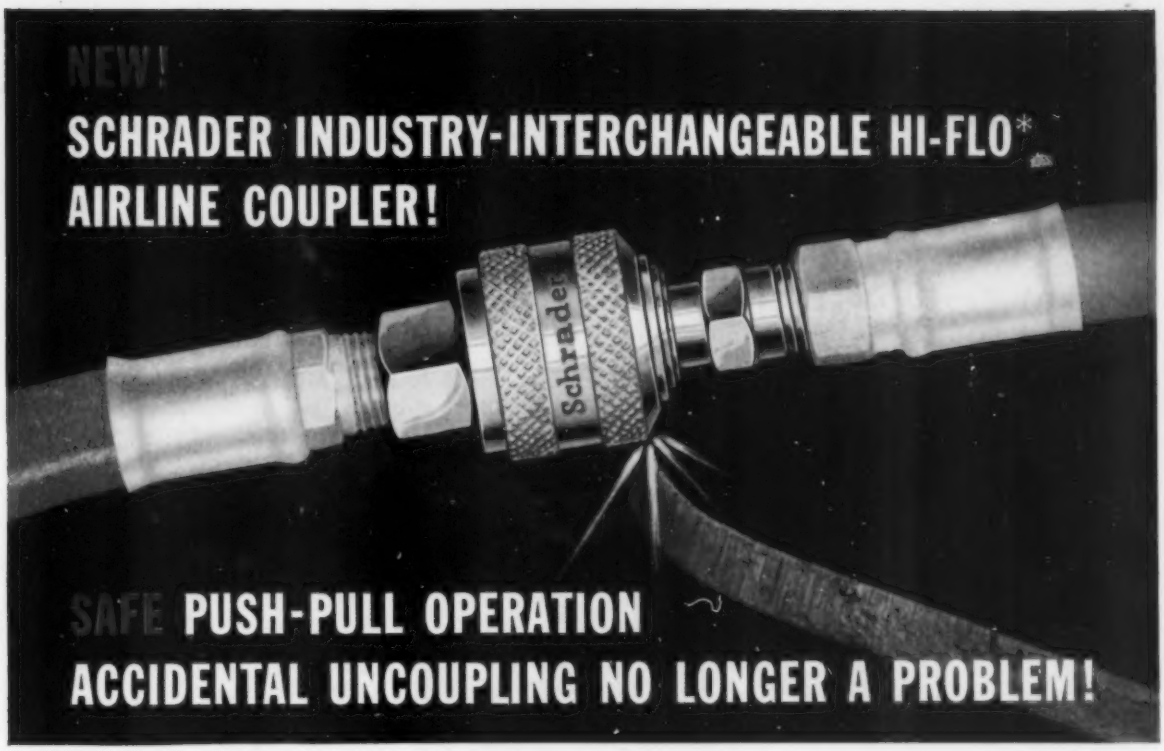
NEW!

SCHRADER INDUSTRY-INTERCHANGEABLE HI-FLO* AIRLINE COUPLER!



SAFE PUSH-PULL OPERATION
ACCIDENTAL UNCOUPLING NO LONGER A PROBLEM!

Schrader's new quick-acting couplers are full of features that afford the best air service. Safety's built in . . . it won't open accidentally even when dragged on the ground and snarled on a piece of machinery . . . yet the heavily knurled new coupler connects and disconnects in a single upstream push or pull with *one hand, gloved or greasy!*

More features: fastest air flow . . . non-corrosive . . . case hardened steel all through . . . meets and exceeds military specs . . . engineered for simple, easy replacement of parts in the field.

Important: Schrader's new coupler is interchangeable with others of similar type. A variety of end fitting styles are available. See your supplier soon.

NEW COUPLER CHECK UNITS AND ADAPTERS

#5139-12–¼ N.P. FEMALE

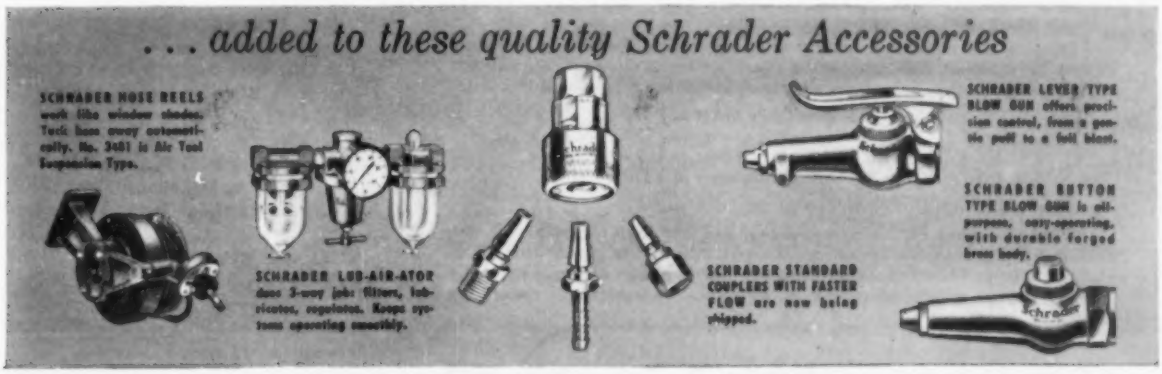
#5138-12–¼ N.P. MALE
#5140-12–⅜ N.P. MALE

#5138-11–¼ N.P. MALE

#5139-11–¼ N.P. FEMALE

#5140-11–SERRATED SHANK FOR ⅜ I.D. HOSE

. . . added to these quality Schrader Accessories



SCHRADER HOSE REELS work like window shades. Twist hose away automatically. No. 3481 is Air Tool Suspension Type.

SCHRADER LUB-AIR-ATOR does 3-way job: filters, lubricates, regulates. Keeps systems operating smoothly.

SCHRADER LEVER TYPE BLOW GUN offers precision control, from a gentle puff to a full blast.

SCHRADER BUTTON TYPE BLOW GUN is all-purpose, easy-operating, with durable forged brass body.

SCHRADER STANDARD COUPLERS WITH FASTER FLOW are now being shipped.

*Reg. U. S. Pat. Off.

Schrader
a division of SCOVILL

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
477 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

CIRCLE 125 ON READER SERVICE CARD 125

Announcing . . .

New Production Capacity

To Serve You Better

Large Generated Gears

SPUR—HERRINGBONE—HELICAL

for a wide range of industrial applications

Gears which must operate smoothly and without vibration at higher speeds and under greater loads must correspondingly be more accurate in tooth profile and spacing.

H & S Generated Gears provide these results.

To meet increasing customer demands, Horsburgh & Scott has broadened its manufacturing capacity and tooled to produce *large* Generated Gears up to 125" diameter.

Offering the same high quality standards which characterize the complete H & S Gear line, production capacities for large Spur, Helical and Hobbed-Herringbone Gears are now available in the following dimensions:

Up to 80" outside diameter at 1 DP
Up to 90" outside diameter at 1¼ DP
Up to 100" outside diameter at 1½ DP
Up to 125" outside diameter at 2 DP

Face widths up to 42", depending on helix angle.

Take advantage of this new capacity, and our long experience as specialists in this field. Send your specifications, drawings or plans — or tell us about your power transmission problem. Our technical staff will promptly consider your requirements and render recommendations and quotations.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue • Cleveland 14, Ohio

films, with technical and processing information, sizes, and prices. Di-Noc Chemical Arts Inc, 1700 London Rd, Cleveland.
Circle 367 on Reader Service Card

RIGHT ANGLE GEARS—Bulletin, 4 pp. Discusses design of right angle gear for 1.5:1 to 10:1 ratios that is said to be competitive with bevel gears. Illinois Tool Works, 2501 N Keeler Ave, Chicago 39.
Circle 368 on Reader Service Card

HIGH-STRENGTH STEEL—Bulletin, 4 pp. Covers engineering and maintenance applications of prehardened, machinable, high-strength steel. Includes typical mechanical and physical properties and tempering curve should lower hardness be desired. Latrobe Steel Co, Latrobe, Penna.
Circle 369 on Reader Service Card

TECHNICAL NEWSLETTER – Tech Notes from Allied is the name of newsletter, to be published 'on occasion', and to feature news and technical developments in the field of electroforming. Allied Record Mfg Co, 6916 Santa Monica Blvd, Los Angeles 38.
Circle 370 on Reader Service Card

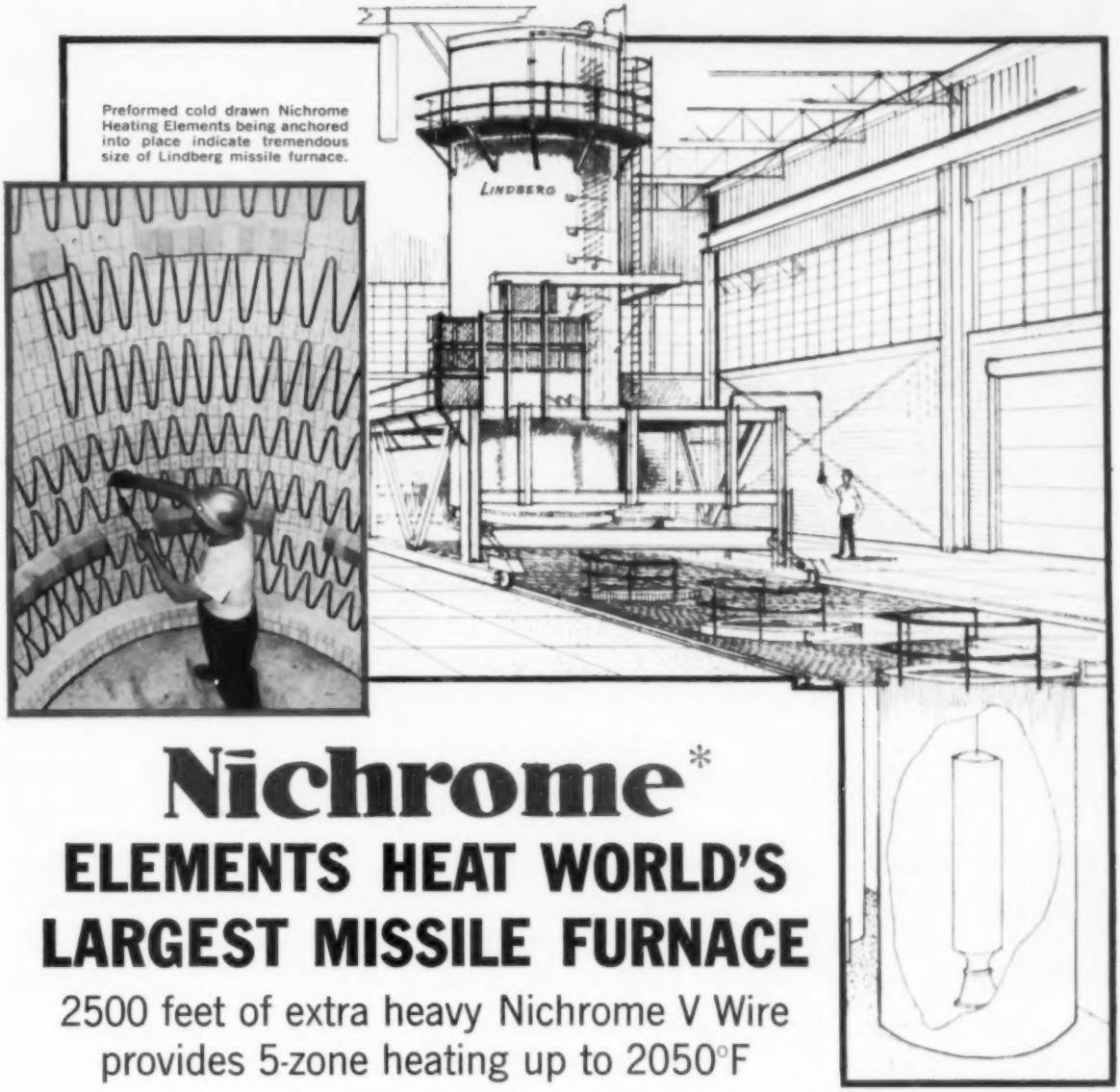
BOBBINLESS PRECISION WIRE WOUND RESISTOR—Brochure GR-30, 8 pp. Presents design factors, construction, specifications and characteristics of three new resistors that eliminate bobbin and float resistive element in special viscous fluid. General Transistor Corp, 91-27 138th Pl, Jamaica 35, NY.
Circle 371 on Reader Service Card

MINIATURE DELAY LINES—Bulletin DL1159, 2 pp. Describes standard line of miniature lumped constant delay lines. With electrical specifications, packaging and construction information. Valor Instruments Inc, 13214 Crenshaw Blvd, Gardena, Calif.
Circle 372 on Reader Service Card

RECORDING ANNUNCIATOR—Bulletin 102A, 4 pp. Illustrates and describes small and large systems to detect temperature, flow, pressure and level process trouble areas. Panellit Inc, 7401 N Hamlin Ave, Skokie, Ill.
Circle 373 on Reader Service Card

SURFACE-MOUNT TEMPERATURE CONTROLS—Catalog sheet MC-186, 2 pp. Gives specifications of series 30,000 temperature controls and 11 modifications. Fenwal Inc, Pleasant St, Ashland, Mass.
Circle 374 on Reader Service Card

MILLIMICROSEC CURRENT GENERATORS—Catalog sheet, 1 pp. Describes two and four-channel models. Modular plug-in unit has fast rise time,
(Continued on page 128)



Preformed cold drawn Nichrome Heating Elements being anchored into place indicate tremendous size of Lindberg missile furnace.

Nichrome*

ELEMENTS HEAT WORLD'S LARGEST MISSILE FURNACE

2500 feet of extra heavy Nichrome V Wire provides 5-zone heating up to 2050°F

This giant 500 KW gantry type Lindberg† hardening furnace is the newest and largest ever built to meet the most exacting heat treating requirements of today's, and tomorrow's, missile metals. It accommodates an effective work load nearly 7 ft. in diameter and 24 ft. long.

Now in operation at Lindberg Steel Treating Company's Melrose Park Plant, the controlled atmosphere installation is both bottom loading and bottom quenching. The 19′ by 57′ pit—28′ deep, beneath the towering electrically heated furnace, houses the loading station, 2 quench tanks (atmosphere and salt) and water wash tank. Work loads pass from furnace to quench through an airtight seal, permitting complete control and precise duplication of atmospheres and treating cycles.

In the hardening furnace there are five control zones which operate between 250°F and 2050°F. Saturable core reactors automatically vary the voltage to the Nichrome*V heating elements between 2.2 and 220 volts, depending on temperature and load.

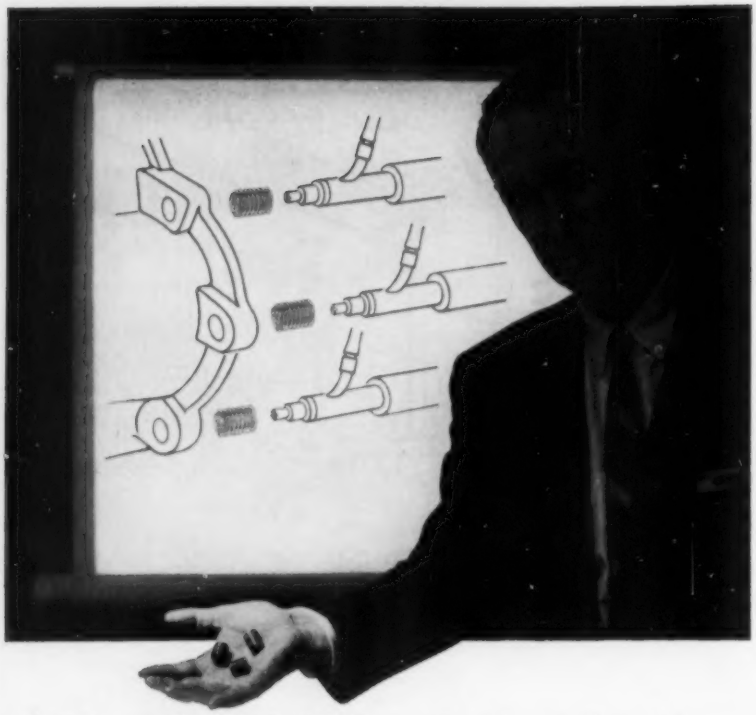
The selection of Nichrome V by Lindberg to supply reliable and closely controlled heat and temperature in this furnace is further evidence of the confidence that industrial leaders have in the quality and performance of Driver-Harris high-nickel alloys. Why not benefit from their experience. Tell us about your requirements. *T.M. Reg. U.S. Pat. Off. †Lindberg Engineering Company

DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES



"These Heli-Coil® Inserts give aluminum tapped holes the strength of steel threads in the new FORD transmission housing."

Threads in the starter mounting pad in the new Ford aluminum transmission housing would have been too soft to resist wear under vibration, impact and removals of the starter for service. ***Heli-Coil*** steel wire inserts eliminate this problem, are installed automatically with ***Heli-Coil*** designed equipment.

Now you can design aluminum assemblies and provide permanent internal steel threads for use with steel screws or studs. And ***Heli-Coil Corporation*** also supplies high-speed, automatic installation equipment to meet mass-production schedules economically.

Opening the door to exciting new design possibilities, *Heli-Coil* Inserts:

- hold fasteners secure under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- allow repeated assembly and disassembly without loss of thread strength
- can be used in standard proportion bosses without need for redesign
- are available in a complete range of U.N.C. and U.N.F. thread sizes as well as spark plug and pipe thread series
- save assembly time, space, weight and cost
- have full industrial and military approval

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, 612 Shelter Rock Lane, Danbury, Connecticut
I'd like more information on ***Heli-Coil*** Screw-Thread Inserts

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ADDRESS_____
CITY_____ ZONE____ STATE_____ 1502

. . . or call Mr. J. L. Sutton, Customer Service Manager, Pioneer 3-7651, Danbury, Conn.

Catalogs and Bulletins . . . . . Continued

high power, current pulse outputs. Electro-Pulse Inc, 11861 Teale St, Culver City, Calif.

Circle 375 on Reader Service Card

COATING PROCESS—Brochure, 4 pp. Describes controlled detonation process for applying coatings to most metals to combine desirable base metal and coating properties. Data card lists physical characteristics of several coatings. Linde Co, Flame-Plating Dept, 300 Madison Ave, Room 904, New York 17.

Circle 376 on Reader Service Card

SMOOTH ID TUBING—Booklet, 4 pp. Specifications on drawn-over-mandrel tubing; account of manufacturing process. Electriweld Tube Div, Jones & Laughlin Steel Corp, 3 Gateway Center, Pittsburgh.

Circle 377 on Reader Service Card

COPYING AND REPRODUCTION TECHNIQUES—Periodical, Vol 1, No 1. Photocopy News and Reproduction Review is intended to report copying and reproduction techniques. Anken Chemical & Film Corp, Newton, NJ.

Circle 378 on Reader Service Card

ENGINEERING AND PRODUCTION FACILITIES—Booklet, 24 pp. Profusely illustrated to show facilities of four plants and research laboratory for development and production of electrohydraulic servo components. Moog Servocontrols Inc, E Aurora, NY.

Circle 379 on Reader Service Card

HOT HEADING—Booklet, 8 pp. Adaptability of hot heading to production in various quantities, configurations and metals is described. With nomograph and information on how to determine volume of material in head forms. H M Harper Co, 8200 Lehigh Ave, Morton Grove, Ill.

Circle 380 on Reader Service Card

Letterhead Requests Only

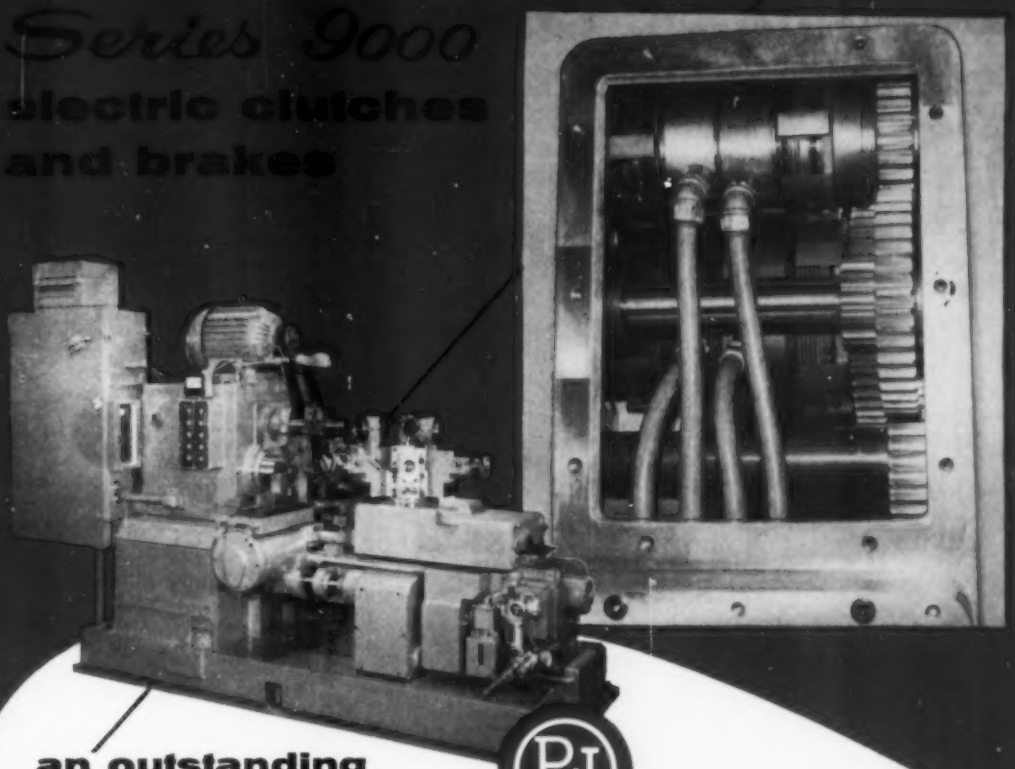
Manufacturers who published following literature asked that requests for copies be made on company letterheads.

STUD-WELDING FASTENERS—Book, 48 pp. Describes stud welding system and provides specifications for stud welding fasteners. Each standard specification page format contains an engineering drawing with dimensions, typical use description, ordering and specifying information. KSM Products Inc, Merchantville 8, NJ.

TRACING PAPERS—File folder. Contains samples of tracing papers with descriptions and price list. Latmer Sales Co, Div of Latmer Printers & Lithographers Inc, 5620 Broad St, Pittsburgh 6.

Maxitorq

Series 9000
electric clutches and brakes



an outstanding design feature of tape-controlled automatic turret lathes

Five Maxitorq Series 9000 Electric Clutches are used in the all-new Potter & Johnston No. 3E-15 Tape-Controlled Automatic Turret Lathe. Four are used in the headstock to provide automatic spindle speed changes and a fifth is used as a master clutch in the feed drive. These clutches of advanced design have PROVED their ability to assure consistent, positive and extremely fast action; essential to these machines. They transmit full load, are self-compensating for wear and permit great flexibility in control.

With operation induced entirely by magnetic flux, Maxitorq Series 9000 Electric Clutches are well adapted to a wide range of machine tool drives. They are simple and rugged in design, require no adjustments, can be used *either as a clutch or brake* and are built to American Machine Tool Standards. Disc separators not only separate discs, providing a drag-free neutral without heating, but also break up residual magnetism and permit extremely fast, positive action.

The 9000 Series Clutches have a minimum of moving parts and the electrical operating unit remains stationary, hence, there are no brushes, slip rings or complex wiring. Maxitorq Clutches operate on 110 V. A. C. rectified to 90 V. D. C. Other voltages on special order.

If you have a clutch or brake application where you are looking for new and improved performance, bring your problem to us.

Phone, wire or write Dept. PE for Series 9000 Bulletin.

The Carlyle Johnson Machine Company, Manchester, Conn.

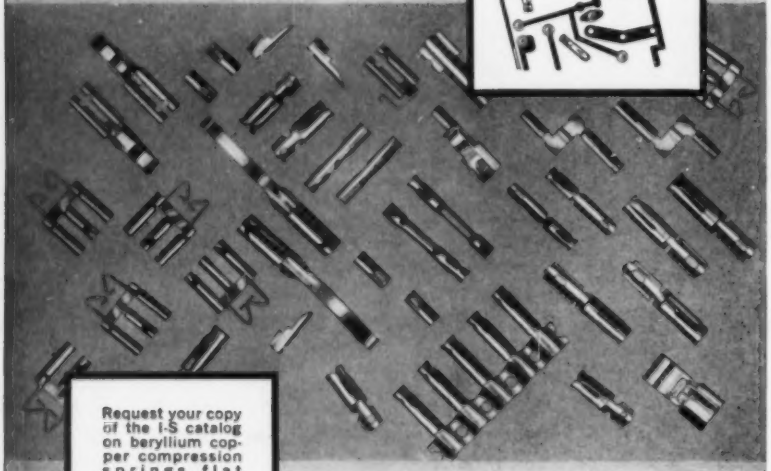
CIRCLE 129 ON READER SERVICE CARD 129

MICRO-PROCESSED FOR COMPLETE RELIABILITY

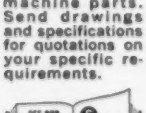
I-S beryllium copper electrical contacts

- Excellent Electrical Characteristics
- Precision Accuracy
- Freedom from Fatigue
- High Efficiency at Elevated Temperatures
- Corrosion Resistance
- Uniform Quality

Increase Dependability of Your Miniature Sockets and Terminal Boards



Request your copy of the I-S catalog on beryllium copper compression springs, flat springs, strip springs, contact strips, contact rings and screw machine parts. Send drawings and specifications for quotations on your specific requirements.



I-S Beryllium Copper contacts provide important advantages both electrically and mechanically. They offer designers and engineers the increased reliability required for today's most critical applications. Custom made contact springs of the types illustrated are produced economically in large quantities by means of automatic tooling. I-S engineers are available to help work out your contact problems and will gladly make recommendations on receipt of your application data; no obligations.

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234 Bergen Blvd., Little Falls, N. J.

Telephone: CLifford 6-3500

"MICRO-...-PROCESSED" I-S BERYLLIUM COPPER SPRINGS

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Engineering-aptitude Tests
How good are they? What the tests are like—and some warnings to the unwary. Nov 30 **Circle P 23**

High-temperature Reinforced Plastics
How they behave under plasma jet, oxy-acetylene torch and rocket-engine exhaust. Nov 23 **Circle P 22**

Mechanical Reliability
Mathematical tools as applicable to bearings, gears and rivets as they are to vacuum tubes or capacitors. Nov 16 **Circle P 21**

Reinforced-plastic Springs
Leaf springs from epoxy laminates can outperform steel. Nov 9 **Circle P 20**

Latest Trend in Bolt Threads
Root radius is getting larger—75% threads now; 55% threads a possibility. Nov 9 **Circle P 19**

18 Ways to Control Gear Backlash
This roundup includes latest devices for answering a chronic problem. Oct 26 **Circle P 18**

Pressure Drops in Pneumatic Systems
New method predicts losses when components are in series. Oct 26 **Circle P 17**

Yardsticks for Research Success
Equations and procedures used to gage the future of a product. Oct 19 **Circle P 16**

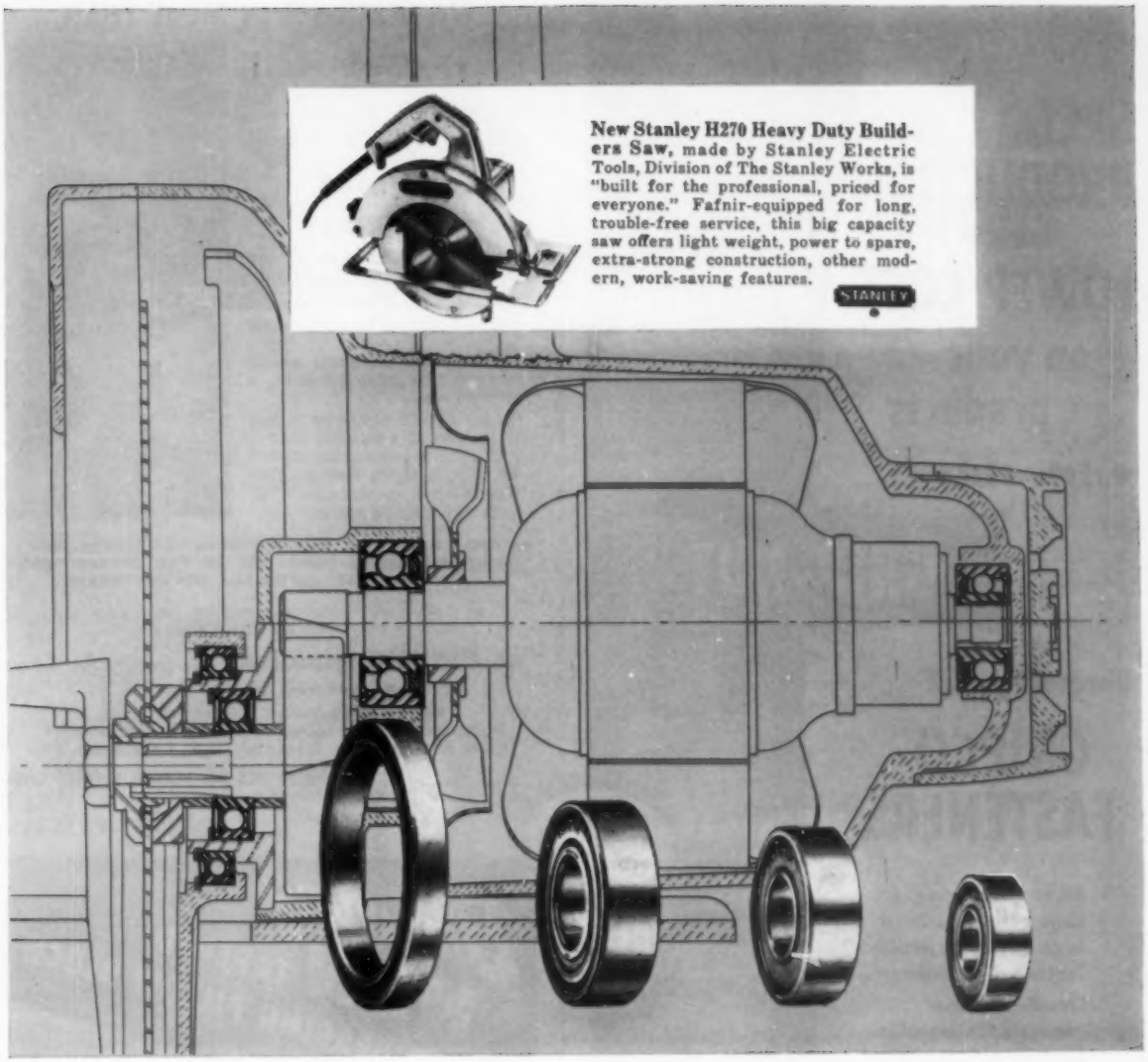
8 Steps to Better Engineering Writing
This eight-part report appeared in serial form from Sep 7 to Oct 26 **Circle P 15**

3 Steps to a Battery-powered Motor
Electric auto is example—how to choose the best motor for the load. Oct 12 **Circle P 14**

Closer Look at Cast Iron
For predicting service performance, look at the miscrostructures. Oct 12 **Circle P 13**

Planetary Drive Run by Rollers
Replacing gear drive cuts noise and vibration in fast planetary system. Oct 12 **Circle P 12**

(Continued on page 133)


New Stanley H270 Heavy Duty Builders Saw, made by Stanley Electric Tools, Division of The Stanley Works, is "built for the professional, priced for everyone." Fafnir-equipped for long, trouble-free service, this big capacity saw offers light weight, power to spare, extra-strong construction, other modern, work-saving features.
STANLEY

New Stanley power saw, Fafnir ball bearing equipped, designed to deliver nearly 40% more cutting force!

Armature, saw shaft, even the blade guard Fafnir-mounted for free-starting, no-maintenance, heavy-duty performance

Nearly 40% more cutting force at working speeds, with 27% less operator effort! This new Stanley power saw represents a design achievement of the first order. And to insure long, efficient service life, Stanley makes generous use of Fafnir precision ball bearings. Even the blade guard is Fafnir-equipped (with an aircraft type bearing), for responsive action at the slightest pressure. On the armature and saw shaft, Fafnir ball bearings all but eliminate friction and wear. Bearing maintenance is eliminated, too. Various combinations of seals and shields lock out contaminants, lock in factory-packed lubricant. No danger of faulty or neglected lubrication... virtually no chance of bearing failure.

Take advantage of Fafnir's "designer's approach" to bearing problems. You'll find Fafnir's breadth of experience and diversity of line insure precise answers. Write The Fafnir Bearing Company, New Britain, Connecticut.

Sealed and shielded Fafnir ball bearings meet specific service requirements in Stanley saws

Felt seal and shield (Motor Armature)

2 Plya-Seals (Blade Guard)

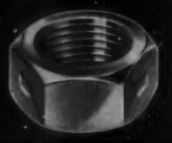
Plya-Seal and shield (Saw Shaft)

FAFNIR BALL BEARINGS

CIRCLE 131 ON READER SERVICE CARD 131

SPEED PRODUCTION and LOWER COST on your products with this GRIP-NUT family of GRIPCO FASTENERS

GRIPCO LOCK NUT
One piece all metal.



GRIPCO CENTERLOCK NUT
Locking feature in the center for fast feeding. Can be applied from either end.

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With or without Gripco Lock. For application to metal too thin to thread or for inaccessible assemblies. Hex collar prevents turning when torqueing bolt.

GRIPCO PILOT-PROJECTION WELD NUT
With or without Gripco Lock. Centering collar positions nut and protects threads from weld spatter.

GRIPCO COUNTERSUNK WELD NUT
With or without Gripco Lock. Countersink protects threads from weld spatter.

All types and sizes of Gripco fasteners listed in catalogue are available for immediate delivery.

Qualified fastener engineers are available for consultation on all your assembly problems.

Other Gripco Products:

- BRASS GRIPCO OR CENTERLOCK NUTS.
- MINIATURE WELD AND CLINCH NUTS, WITH OR WITHOUT LOCK.
- GRIPCO AND CENTERLOCK HI NUTS.
- STANDARD SEMI-FINISH FULL AND JAM NUTS.
- STAINLESS STEEL LOCK, WELD AND SEMI-FINISH NUTS.
- COLD FORMED SPECIAL NUTS OR PARTS TO PRINT.

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GASKETS PACKINGS WASHERS
SEALS SHIMS BUSHINGS "O" RINGS

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Put our 87 years experience to work for you—Auburn's engineers are tops in their field in designing and fabricating precision sealing devices. Their know-how is at your command. "O" Rings are a speciality with us.

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Send us your specifications or blueprints. You'll receive prompt quotations and recommendations without obligations.

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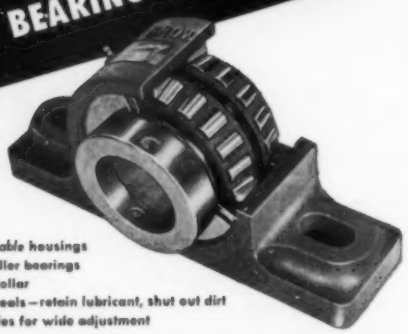
306 Stack St., Middletown, Conn.

New York, N. Y.; Rochester, N. Y.; Detroit, Mich.; Chicago, Ill.; Minneapolis, Minn.; Pittsburgh, Pa.; Cincinnati, Ohio; Ridgewood, N. J.; Atlanta, Ga.; Memphis, Tenn.; St. Louis, Mo.; Camden, N. J.; Washington, D. C.

CIRCLE 205 ON READER SERVICE CARD

Browning NEW TAPERED ROLLER BEARING PILLOW BLOCK



★ unbreakable *malleable* housings
★ Timken tapered roller bearings
★ eccentric locking collar
★ labyrinth grease seals—retain lubricant, shut out dirt
★ elongated bolt holes for wide adjustment

Compare! Here is the only heavy duty roller bearing with eccentric locking collar to ensure firm shaft grip. It is designed with housing of *unbreakable malleable*, which provides extra strength, permits more compact design, lighter weight. And new tapered rollers specially designed by Timken for Browning, compensate automatically for normal misalignments. Now in distributor stock, 24 shaft sizes from 1 3/16" to 4". Elongated bolt holes provide wide adjustment and interchange. Ask distributor for complete details and bulletin BU-102A, or write **Browning Manufacturing Company, Maysville, Kentucky.**

Browning POWER TRANSMISSION EQUIPMENT

CIRCLE 206 ON READER SERVICE CARD

Current Reprints .....continued

Molding with Polyester Premixes
A different design approach is necessary with these reinforced plastics. Oct 12
Circle P 11

Ballbearing Tests
Combined reprint: test methods for torque, vibration and runout. Sep 14; devices to check preload and play. Sep 28
Circle P 10

Specifying Anodized Aluminum Finishes
Practical guide to ways that will give the specific coating needed. Sep 28
Circle P 9

13 Ways to Cut Drafting Costs
List of helpful modern methods, materials and equipment that save money. Sep 28
Circle P 8

Fixed Resistors
Three-step method chooses type and rating for power and control. Sep 28
Circle P 7

More Engineering per Engineer
Review of new techniques designed to reduce the noncreative load on engineers. Sep 21
Circle P 6

Equipment Says It in Color
How eye-catching color code conveys information from machine to operator. Sep 14
Circle P 5

New Data for High-pressure Air
Properties of air under pressure. Curves useful from 0 to 12,000 psi and −150 to 250 F. Sep 14
Circle P 4

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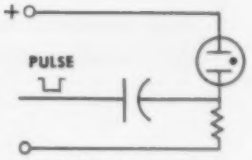
4 ways to use

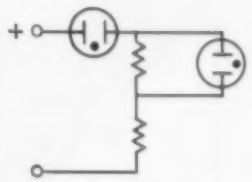
General Electric Glow Lamps as Circuit Components

1. As a MEMORY DEVICE, because of the differential between starting and operating voltages. Both the General Electric NE-96 and NE-97 are well suited for switching circuits and counters where they can function as transfer elements and as indicators of state or sequence.



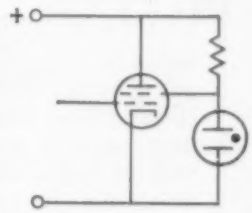
G-E Glow Lamp used in Memory Circuit

2. As a VOLTAGE INDICATOR, because of their critical starting voltage. The G-E NE-76 and the NE-81 are stabilized and selected for close tolerance on starting voltage. Both find use in gating circuits, logic matrices, switching circuits or as an indicator of input or output levels.



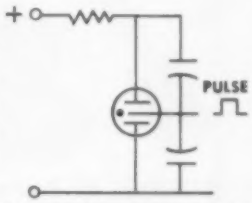
G-E Glow Lamps as Multiple Voltage Indicators

3. As a VOLTAGE REGULATOR, because of their constant operating voltage range. The General Electric NE-68 and its "first cousin", the G-E NE-80 (closer tolerance), function effectively wherever voltage regulation is required. (Glow Lamps for higher current applications are also available.)



G-E Glow Lamp used as a Voltage Regulator

4. As a TRIGGERED SWITCH. A low current signal applied to the trigger (third electrode) starts this lamp, permitting conductance of peak current surges up to 100 m.a. in the power circuit. It can be used in counting circuits or as a control device with photocells, thermostats or moisture sensors in trigger circuit.



G-E NE-77 in a Trigger Circuit

Choose the General Electric Glow Lamp best for your circuit requirements. For further information, write for "Glow Lamps as Circuit Control Components". General Electric Co., Miniature Lamp Dept. M-909, Nela Park, Cleveland 12, Ohio.

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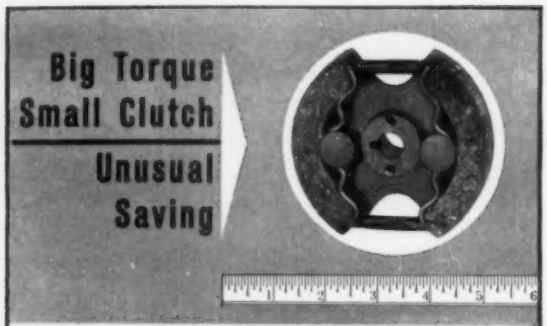

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tangents...

Design for Christmas

Thirty years ago, when *Product Engineering* was new, the then managing editor assigned me "a Christmas story" for the December issue. That was broad—and vague. The only Christmas products I could think of were toys, particularly trains.

So I went to Lionel for an engineering story—and was rejected. (It turned out later that both engineering and die-making were being done in Italy.) Next call was on American Flyer, where the general sales manager, who'd overheard me explaining to the New York manager what I wanted, overruled his subordinate's negative decision. I was swamped with data and pictures, and quite impressed by the detailed design of components and the variety of materials and processes. Design was a faithful miniature of full-sized trains, eg's and curves were figured for the equivalent of 40-mph speeds, long-lived materials were used for crucial parts.

To my amazement, I learned that this was a dog-eat-dog business like everything else, in which the designer's skill at innovation was often the deciding factor between profit and loss. Both companies had recently provided smoke tablets for their locomotives, and American Flyer's exclusive development of an automatic mailbag catcher had so upset Lionel's previous season that the only profitable item the latter had had was "Mickey and Minnie Mouse on a hand car." Also, boys were insisting on detailed authenticity, and Lionel's "foreign" look hadn't helped sales. In fact, the general manager explained that the first company to develop an authentic-sounding train whistle would drive the other to the wall. (A year or two later, Lionel—with Americanized designs—got the whistle, and American Flyer was sold to Gilbert.)

Thus the designer is the key to business success. Even so, he is often at the mercy of his young customers. That same season, American Flyer engineers worked out an extremely complicated multiple-train layout. It was set up in a show window near company offices in New York, after several days to iron out the bugs. It was unveiled late one afternoon, with a placard offering the company's most-expensive train set to the first youngster to sketch the layout. Next morning, when the staff arrived at the office, they found a 14-year-old sleeping in the doorway, the correct solution clutched in his hand.

This is not unusual. During the time in which I worked on the story, I consulted several youngsters with train sets. I found that they'd not only memorized all available literature, but had also done a good deal of empirical research and testing.

When published, the story drew tremendous numbers of requests for reprints—more than any other of its time. Engineer-readers who asked for it insisted it was for their sons—and who were we to debate it?

At the same time, I got a short article describing design tricks used at Kilgore in turning out cast-iron toys for 10-cent stores. That was in the days when the toys actually sold for only ten cents, so production costs had to be figured to four decimal places to hit under $.0350, as I recall. The result was extremely ingenious design. One I remember was a tiny malleable casting for a Kiddie-Kar seat, made that way so the pivotable front-axle assembly could be snapped into place

(Continued on page 136)

"What we need around here is team work . . . now you get on that drawing board and I'll do the thinking. . . ."

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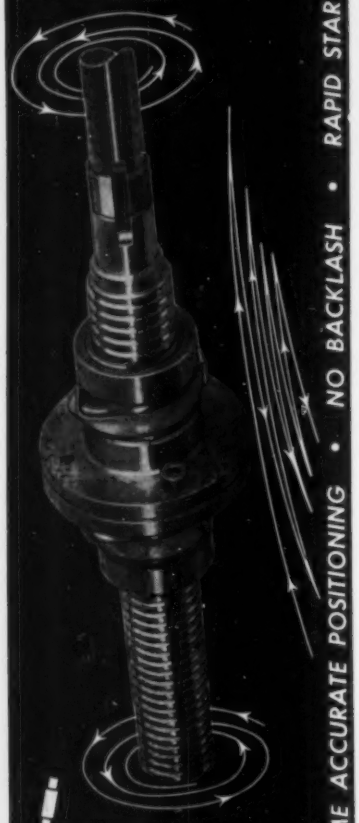

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in a fork. Another was a tiny working clothes wringer complete with rubber rolls—tubing slipped over wires in assembly. A third was a tiny table which slid apart to allow insertion of an extra leaf, the slide being held by a U-shaped wire spring.

But the prize yarn of all came up a couple of months later, when I covered the Annual Toy Fair. (Toys are exhibited, and sold, to dealers in February, from makers' booths in two New York hotels.) As I walked down a hall, I smelled the aroma of baking bread. In one room was an exhibit of toy electric stoves and vacuum cleaners—and the exhibitor was the baker.

I couldn't help grinning at a "big burly business man baking bread," and he was ready to bite my head off. Turned out he was president of the company as well as design chief, a PE reader, and a former shopman at Wagner Electric in St. Louis. When he cooled down, he showed me that switches and coils in his stoves met Underwriters' specs, and that stoves were authentic working models, as his baking proved. (The bread was good!)

He'd backed into the toy business, it seemed. He'd quit Wagner to make a little black traveling iron for ladies. The irons sold slowly for a year or two, until one day a Macy buyer asked him if he could enamel them in color. For a 1000-iron order, he'd have gold-plated 'em at that point—

(Continued on page 137)

"These aren't my own figures. They're the figures of someone who knows what he's talking about."

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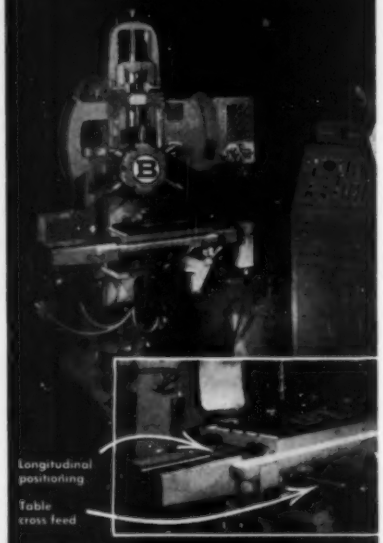

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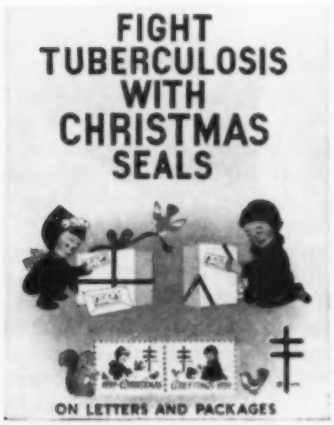
so he followed orders closely. And Macy reorders came in, in quantities that kept him jumping. Was there something about New York City that made it a better sales area or did Macy have some special sales idea? Was the color the secret of added sales?

He tried to find out how Macy sold so many, but the buyer just laughed and said, "You make 'em; we'll sell 'em!" He tried to interest his other customers in colored irons, but they stuck to black, and sold only a few. Finally, his curiosity became so great that he came to New York to do a little checking up. He found none of his irons in the Macy kitchen or hardware departments, only two black ones in the luggage section. Finally, with the mystery unsolved, he went to the toy department to pick up toys to take back to his children. There were his irons!

He was infuriated, of course—felt like he'd been made a fool. But when he calmed down, he went home to make electrical toys. And he'd made a killing. When we talked, he said his next product would be a toy washing machine. His problem at that point was simple: When Sis asked Mom for soapy water, Mom was likely to pick up the whole washer and dip it into her own suds—and that's hard on a motor. (The next year he had an enclosed motor, so all was well.)

I've often thought of those interviews when some engineer tells me of his problems. He's at least making a reasonably sized and priced product, and not betting his company's whole bankroll on a Christmas toy. —EJT



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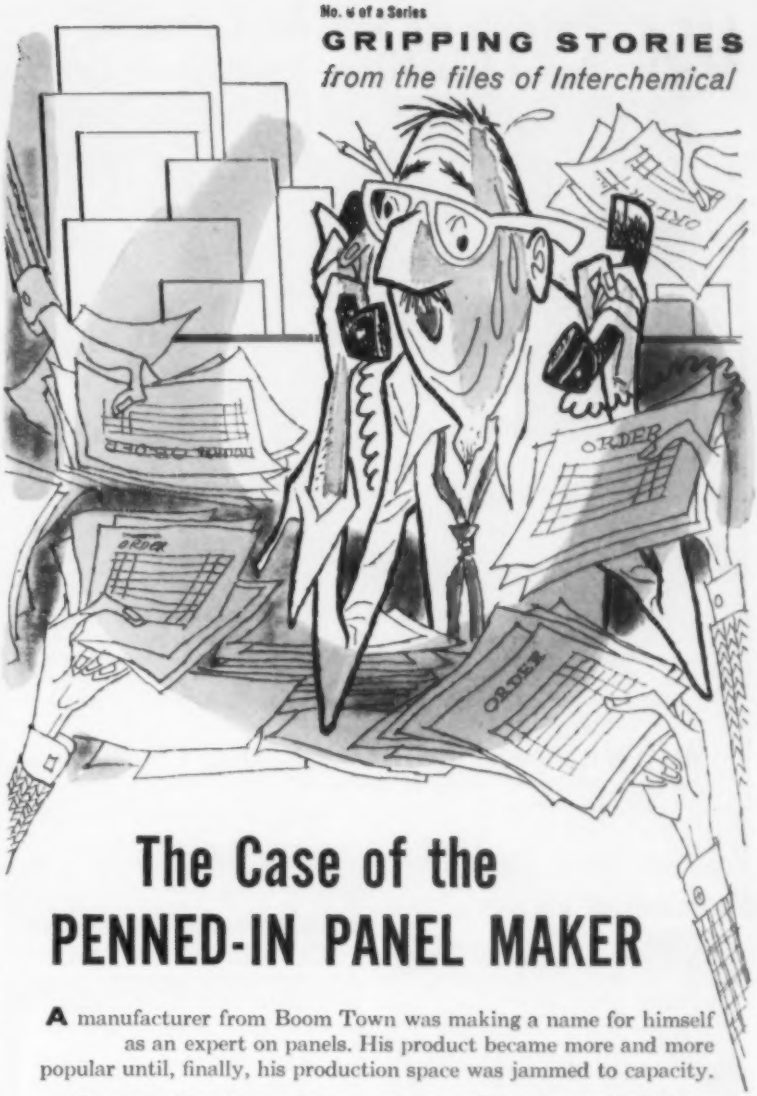

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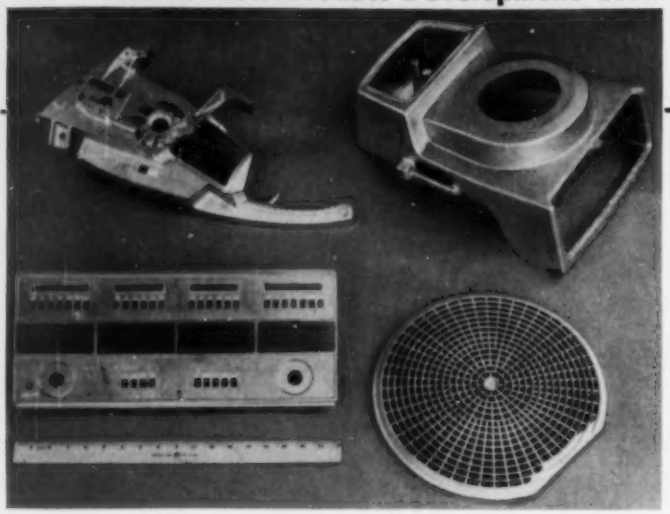

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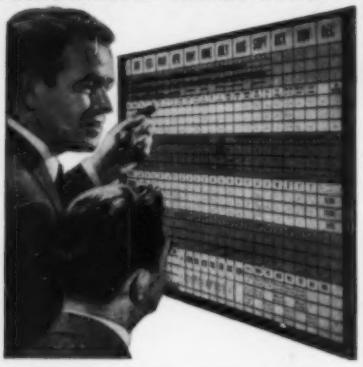

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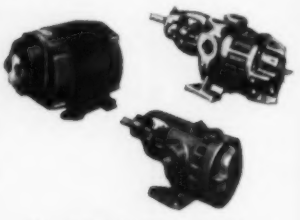

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Ten Commandments for Reliability

Ten basic rules for the designing of equipment requiring high levels of reliability are discussed. These are based on simplifying, inspection and checking, minimum of required functions, minimization of human factors, selection of correct level of reliability.

"Design for Reliability," B. B. Richardson, Northrop Corp. Society of Automotive Engineers paper 101U, SAE, 485 Lexington Ave., New York 17.

Simplifying Motor Power-factor Correction

Chart is provided that can be used to determine: 1) how much capacitance is needed to correct power factor of an induction motor; 2) power factor that will be obtained with given capacitor and motor.

"How to Simplify Motor Power-factor Correction", G. R. Brooks, Allis-Chalmers Electrical Review, 3rd Quarter, 1959, Milwaukee 1.

Reduction of Static Friction

Effect of sonic vibrations on the coefficient of static friction was measured for highly polished, ground, and sand-pitted steel surfaces. The coefficient of static friction can virtually be reduced to zero as a result of increased vibrations at frequencies between 6 and 42 kc.

"Reduction of Static Friction by Sonic Vibrations," Hans D. Fridman, Massachusetts Institute of Technology and Pascal Levesque, Raytheon Mfg Co. Journal of Applied Physics, Oct 1959, 335 E 45 St, New York 17.

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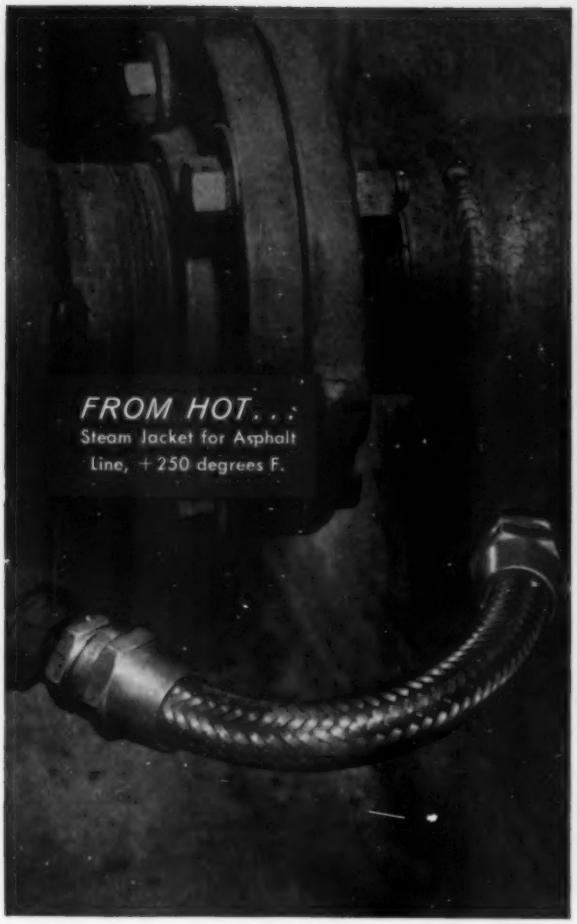
(Continued on page 140)



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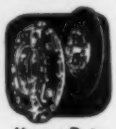
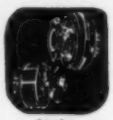
Automotive Spring Loaded


Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center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"Evaluation of Ablation Materials for High Temperature Application," Schwartz, Bandaruk, and Mills, Aeronautic Div, Ford Motor Co. SAE paper 98T, SAE, 485 Lexington Ave, New York 17.

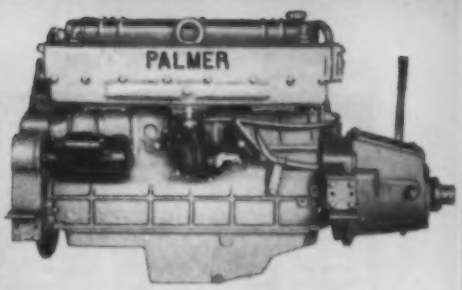
Which Secrets Should Be Kept?

Here are four positive reasons for being less reticent in matters of interest to the technical press:

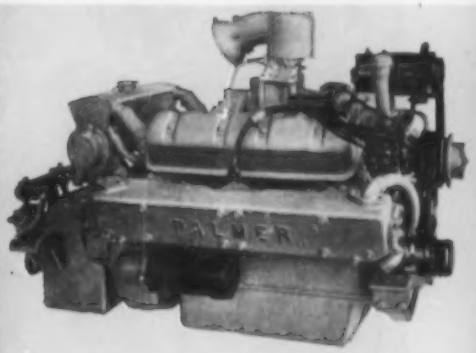
A feature article in a leading business publication enhances the stature of the individual who wrote it; a company mention in the by-line or body of an article helps to establish it as a source of sound technical data; assuming that secrets indeed are hard to keep, why not take the credit for being the first to figure things out? If you wait until the competition gets your know-how, you may be sure that they will rove more alert to its publicity potential, and will exploit it to the fullest; a company that consistently appears in the business press

(Continued on page 143)

"I said, I wonder why people don't like me—Open your ears, fathead!"



This 32-ft. custom built cruiser has a 28 mph. top speed. Power is provided by pair of International 6-cyl. engines with 264 cu. in. displacement.



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"In this process of evolution, Palmer has used a number of mass-produced industrial and automotive assemblies, but we never experienced such success as that which came our way after we began using International engine assemblies five years ago. Our sales have increased over 500% in five years and the boating public, both commercial and pleasure, has come to know that an International-Palmer marine engine means the utmost in power, dependability and economical operation. We look forward to the future with confidence that our International marine engine sales will re-double many times and that our International diesel marine sales will soon become a big factor in the industry."

See the Palmer exhibit at the National Motor Boat Show, New York Coliseum, January 13-24, and call or write International Harvester Co., Engine Sales Dept., Construction Equipment Division, Melrose Park, Illinois, for information about this outstanding 24-model engine line. Power range is 16.8 to 385 max. hp, diesel or carbureted.

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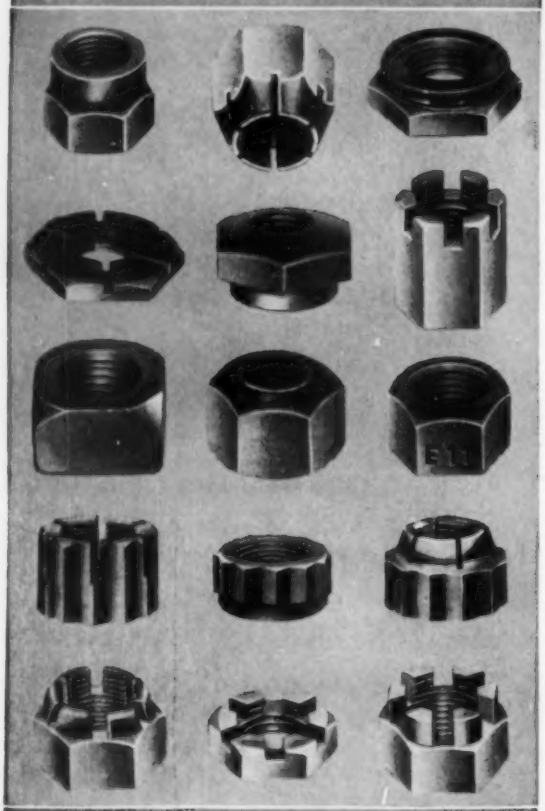

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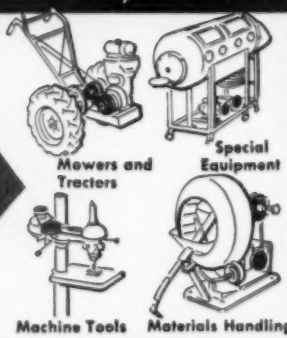

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with new ideas, new developments, or new methods comes to the attention of engineers who depend on these publications to keep them up-to-date with the latest state of the art.

"I've Got A "Secret" " L R Grief, Grief Associates, Inc. Plastics Technology, Oct 1959, 630 Third Ave, New York 17.

Tolerances Clarify Design Intent

This paper discusses ambiguous bilateral systems and then explains positional tolerancing, the bonus tolerance available through the maximum material concept, how positional tolerancing dictates inspection criteria, and closes with a new concept called "paper gaging." This paper presents only a basic and partial explanation of a dimensioning technology increasing in scope and use.

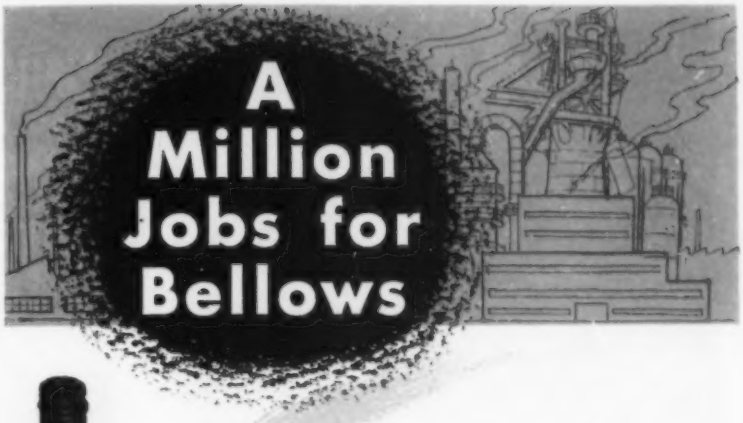
"How Positional Tolerancing Clarifies Design Intent and Reduces Product Cost." Edward S Roth, Sandia Corp, ASTE paper 225, ASTE, 10700 Puritan Ave, Detroit 38.

New Equations for Roller Bearings

Despite their mechanical simplicity, ball bearings present some very complex problems when under service. Closed-form solutions are known for relatively few, simple cases of loading because ball bearings are statically-indeterminate, non-linear spring systems and the associated equations are exceedingly cumbersome. Also, existing solutions do not properly account for the variations of contact angle within a ball bearing under complex loading conditions.

The analysis here advances theory to include dynamical effects as well as structural yields. It is programmed for an IBM-704 digital computer and, in addition to bearing compliances, structural yields and internal load distribution, the general equations yield data on: contact area dimensions and stresses at each ball position, locations of pressure ellipse extremities, centrifugal forces and gyroscopic moments on the balls, friction torque due to rolling, theoretical fatigue life, and many other items.

"A General Theory for Elastically Constrained Ball and Radial Roller Bearings Under Arbitrary Load and Speed Conditions", A. B. Jones, Chief Research Engineer, Fafnir Bearing Co. ASME paper 59-LUB-10, ASME, 29 W 39 St, New York 18.



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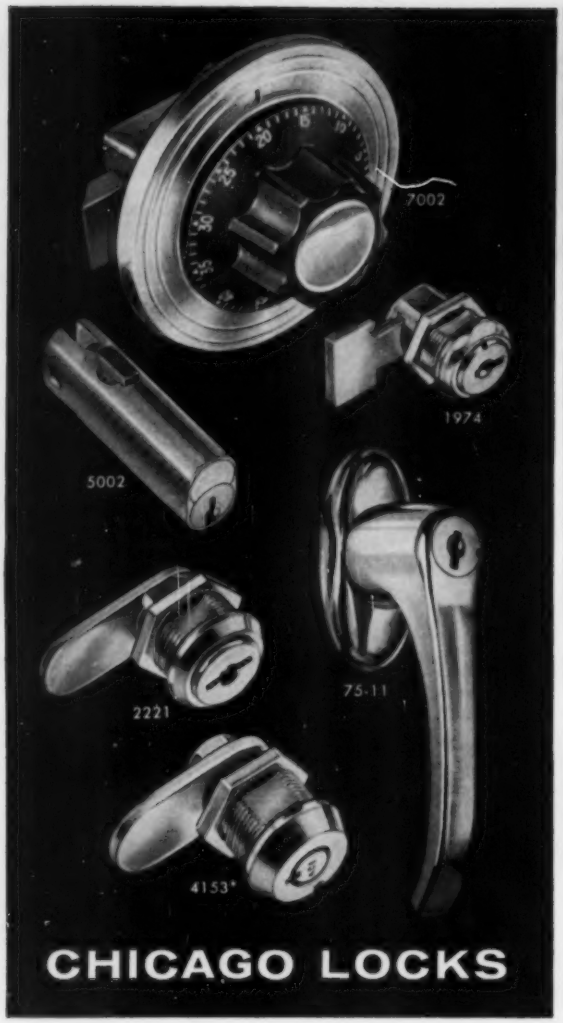

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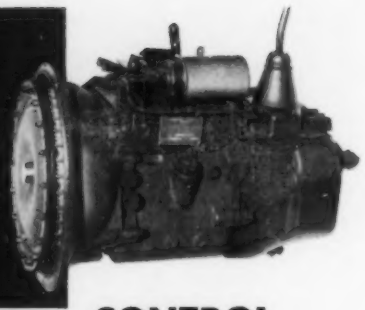

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NEW BOOKS

Principles of Analog Computation

GEORGE W SMITH, ROGER C WOOD. McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6¼ x 9¼, 234 pp. $7.50.

For the reader who is primarily interested in putting the analog computer to work on a practical problem, this book provides him with the analytical tools he will need. Primary emphasis is given to the types of problems that can be solved, use of equipment, and current practices. The book covers considerably more material than is generally given in a one-semester course in analog computer operation but does not discuss any of the usual design features. New techniques that involve diodes are introduced here, and there is a lengthy discussion of smoothing methods for diode function generators.

Kinematics

VIRGIL MORNING FAIRES, Professor of Mechanical Engineering, US Naval Postgraduate School. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 6¼ x 9¼, 468 pp. $8.50

This book discusses those subjects in the science of motion that are of most general interest to engineers. Recent advances in cam design are included. Both graphical and mathematical approaches are covered, including cycloidal motion and combinations of different motions during one stroke. The concept of "jerk" is emphasized. The procedures for designing gear trains, rolling curves, and linkages are discussed, and a short chapter on synthesis of mechanisms is included.

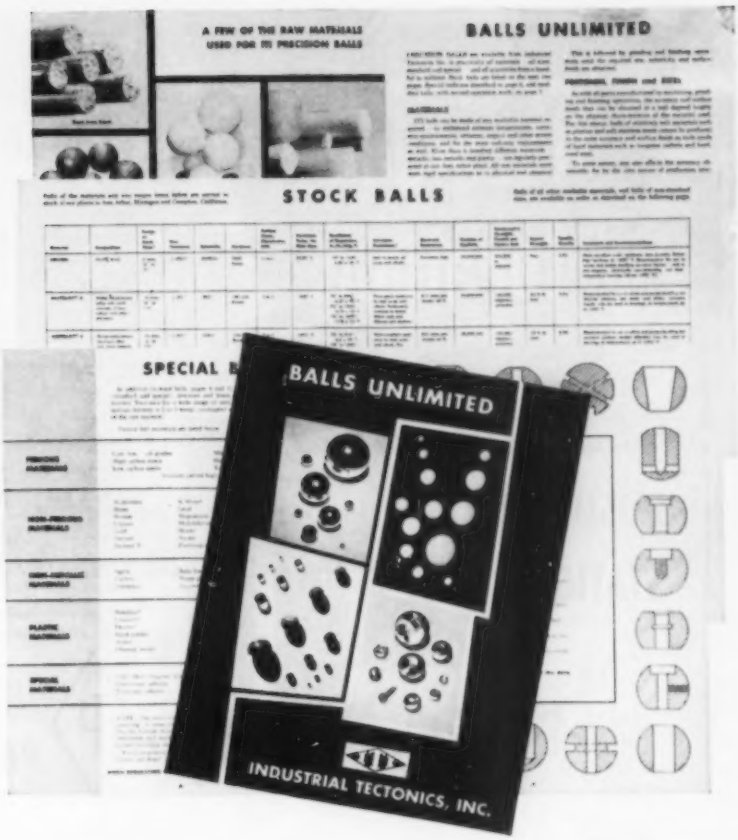
Other topics include: relative angular velocities, virtual work from velocity vectors; acceleration images; coriolis acceleration; mathematical solution of gear problems.

Engineering Statistics

ALBERT H BOWKER, GERALD J LIEBERMAN. Prentice-Hall Inc, Englewood Cliffs, NJ. 6¼ x 9¼, 585 pp. $11.

If you graduated from engineering school more than five years ago it's a safe bet that you didn't take a course in statistics unless you were headed toward production engineering—quality control was statistics' most fre-

(Continued on page 147)



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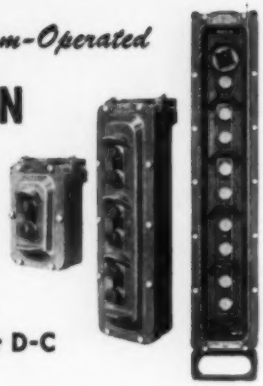

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Acro-Lite metal-enclosed visual indicator switch. Electrical rating: 21 amperes, 2 H.P. — up to 75 amperes inrush current.

Paramount aluminum die castings make up the sturdy protective housing of the new Acro-Lite switch manufactured by Acro Division of the Robertshaw-Fulton Controls Co. Casting design permits quick, easy assembly of the switch and housing. Castings require no machining except for tapping.

PARAMOUNT zinc, aluminum and magnesium die castings can help solve your product problems.

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quent application to engineering at that time. Today's design engineer is finding a number of other applications for this tool that helps him make decisions in the face of uncertainty. He's using it to set realistic tolerances, to set up tests and evaluate the results, to measure reliability of a design prototype.

Here is one of the few books on this science written specifically for engineers. It assumes no previous contact with statistical concepts or the mathematical techniques. Both authors are statisticians; Dr. Lieberman is also an engineer. The statistical subjects discussed are those of particular interest and practical value to engineers. This is neither a "cook book" nor a mathematical treatise—the working concepts are emphasized, and detailed mathematical details are marked for optional reading.

Tool Engineers Handbook Second Edition

American Society of Tool Engineers. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 6 x 9, 2289 pp. $19.50.

This monumental reference volume covers all phases of tool engineering involved in the mechanical processing of finished products. Its style and arrangement is best suited to fast, easy usage, and gives dependable answers needed in making or affecting every variety of tool engineering decision.

This edition has been updated in line with modern materials, methods, and machines. Such topics as spark machining, electrolytic grinding, surface cleaning by supersonics, and many other comparatively recent topics are

(Continued on page 149)

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Townsend lockbolts are also available in carbon steel and aluminum alloy in a wide range of diameters and grip lengths in brazier, button and 90° countersunk head styles. Write today for information to Engineered Fasteners Division, P.O. Box 71-D, Ellwood City, Pennsylvania.

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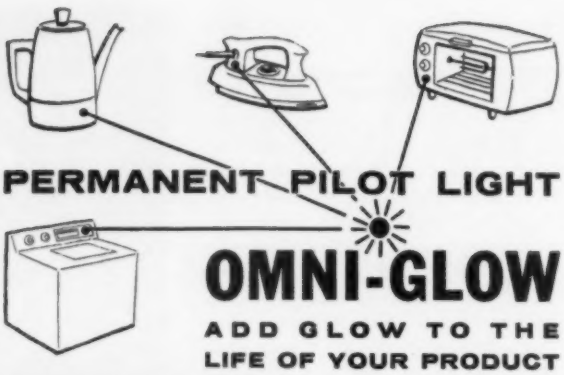

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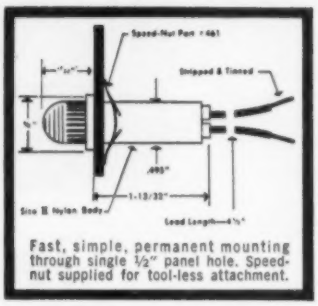

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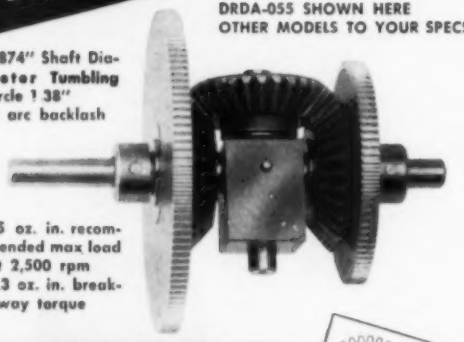

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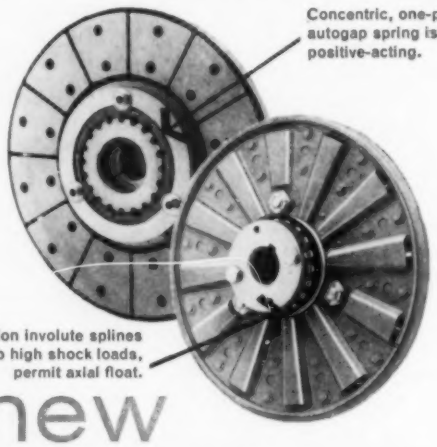
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covered. Although dealing with production rather than product design, this reference should be at every design engineer's elbow. It will be of great practical use and can even help produce better decisions — ignorance of manufacturing methods sometimes complicates design unnecessarily.

Men of Science in America

BERNARD JAFFE. Simon and Schuster, 630 5th Ave, New York 20. 6 x 8½, 670 pp. $6.95.

This book presents a broad picture of the growth of science in the US. The story is told in terms of the lives and achievements of the scientists themselves. It starts with Master Thomas Harriot, who came to America in 1588 with Raleigh's expedition and who, in addition to his investigations in the field of mathematics and astronomy, was the first press agent for tobacco. It goes on to cover the work of Benjamin Franklin, Benjamin Thompson, the anesthetist William Morton, biologist Louis Agassiz, the mathematical physicist Willard Gibbs, the aeronautical pioneer Samuel Pierpont Langley, and others. It deals fully with the great 20th century scientists and ends with such contemporary trail-blazers as Enrico Fermi, J Robert Oppenheimer, and Selman Waksman.

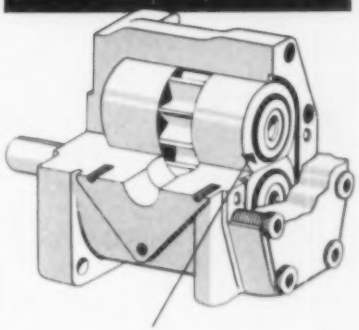
The reader has an opportunity to note the influence that historical, political, and social events have had upon the scientific development of this country. The book will give Americans much pleasure and pride. The scientific progress achieved in less than two centuries in this country is almost incredible. There never has been a time when Americans could not refer with pardonable vanity to a few contemporary scientists, yet collective triumphs began only in this, our century.

Jaffe points out: "The year 1932 was a real annus mirabilis in the the history of science. Four great discoveries and inventions were made in that single year. The neutron, heavy hydrogen, and the positron were all brought to light for the first time, while the first practical cyclotron was added to the key instruments of physical science. It is interesting to note in this connection that three of these four milestones were first

(Continued on page 151)

HYDRAULIC Gear Pumps

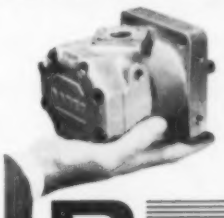
Pressure balanced for efficiency



The application of discharge pressure to the bearings as shown creates an optimum counter balancing thrust toward the gear faces which controls leakage and wear.

This feature permits operation with volumetric efficiencies in excess of 90%. Pump sizes from ½ to 60 GPM in 15 models with pressures to 2500 PSI. Also available as gear motors with outputs to 25 HP.

DOWTY
Hydraulic Gear Pumps



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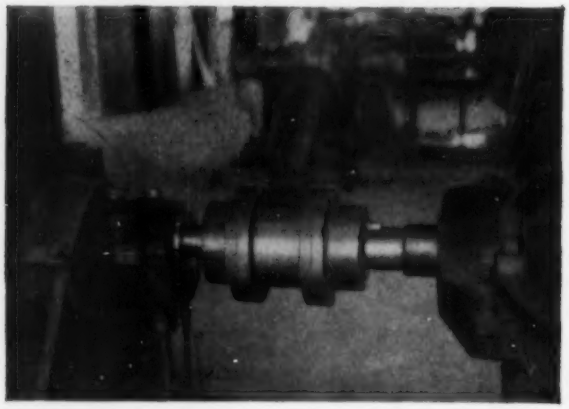

Waldron standard coupling on crude oil pumps on 20" line from Wyoming to Indiana.

John Waldron makes a complete line of standard couplings. They are all designed to transmit maximum power smoothly and safeguard the connected machines from the effects of misalignment which occur during operation. And, outside of periodic lubrication, the couplings never need maintenance. Hence, once these couplings are installed they will run continuously over the years (often outlasting the equipment they couple) with minimum care and maximum efficiency.

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H H ZUIDEMA, Product Applications Dept, Shell Oil Co. Reinhold Publishing Corp, Dept B-332, 430 Park Ave, New York 22, 6 x 9, 192 pp. $7.

This new edition summarizes and evaluates data on the performance characteristics of lubricating oils under various conditions. It incorporates many papers on the subject published since the first edition. Selected references add to the bibliography in each chapter, and corresponding re-

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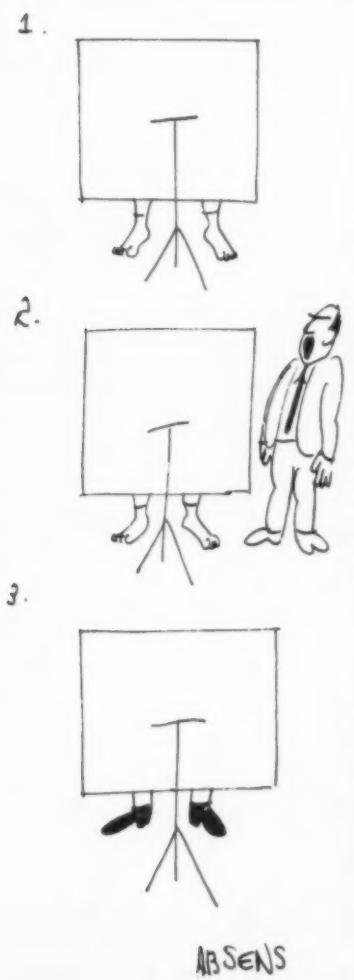

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visions and additions appear in the text. The book also supplies helpful charts, tables and illustrations.

Subjects new to this edition include multigrade motor oils, fretting wear and paper chromatography. Chapters are included on lubrication processes, rheology, oxidation, bearing corrosion, sludge and lacquer deposition, emulsification and foaming, and manufacturing methods.

Company Climate and Creativity

Prepared by Deutsch & Shea Inc. Industrial Relations News, Books Dept, 230 W 41st St, New York 36. 9 x 11¼, 103 pp. $10.

The book is based on a survey of 105 scientists and administrators in a variety of fields including psychology, sociology, scientific and engineering education, industrial menagement, marketing. The results emphasize the most important factors affecting working conditions for those involved in creative work. The study is intended as a guide for anyone concerned with developing programs aimed at improving the "climate" for such work.

Dynamic Product Development

PB 151649. SIDNEY SOBELMAN. A Modern Dynamic Approach to Product Development. Distributed by Office of Technical Services, Dept of Commerce, Washington 25, DC. Paperbound, 8½ x 11, 200 pp. $3.50.

To manufacture or not to manufacture is the problem facing many a product planning department. The answer to this question depends on answers to subordinate questions "What will it cost to develop?" and "How many can be sold—at what profit?" Mr. Sobelman cannot answer these questions with any degree of certainty—nor can anyone else. Developing a new product for the marketplace is still a gamble. But with the methods proposed in this book, gambling is more scientific; odds are reduced to those of a calculated risk.

Key to the method is the product payoff formula. An extract from this book ("A Dollars and Cents Evaluation of New Products," June 29, '59, p 21) described the mathematical model and showed how it picks the most profitable combination of new products from a group of candidates. The book, of course, is more circumspect. It discusses in detail: cus-

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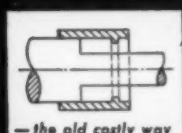

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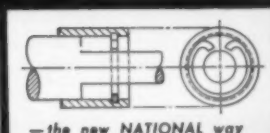

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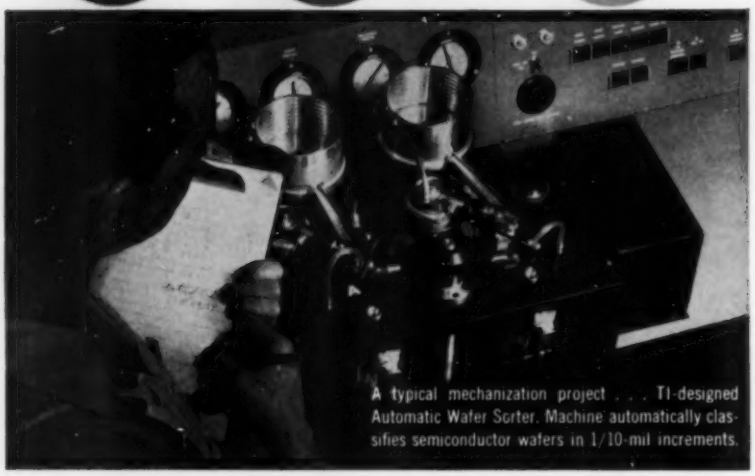

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tomer's needs, other methods of evaluating new products, climate and organizational structure for efficient product development, funding and budgeting. Mr. Sobelman is employed by Picatinny Arsenal and many of his examples come from military products. However, material for this book is a result of a year spent studying large corporations both in this country and abroad; thus his methods are applicable to new products in a wide variety of industries.

Impact and Shock Resistance of Plastics

PB 151729. Report of work by Dept of Engineering Research, North Carolina State College and Bureau of Ships. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 11, 38 pp, $1.25.

This is a report on development and initial application of a mechanical impact tester now in use by the Navy (*PE—July 27, p 15*). It gives basic design features and tells how the machine can be used.

Property Measurements at High Temperatures

W D KINGERY. John Wiley & Sons Inc, 440 4th Ave, New York 16. 10 x 7, 416 pp. $16.50.

High temperature, in this book, refers to temperatures above 2550 F. Therefore, its usefulness is in an area above the range of most present-day design and closer to R & D. Although the topic here is property measurement, the book includes much useful information on the properties themselves, particularly on refractories that must be used to contain these temperatures.

Understanding properties above 2500 F can often be very helpful in solving knotty problems at lower temperatures. The book is worth its high price if superhigh temperatures affect your line of work.

CORRECTION

The inch-to-meter conversion in Machinery's *Handbook* (reviewed Nov 9, p 174) was based on 1 in. = 25.4 mm exactly, agreeing with the new ISO standards. But ft-to-meter conversion in the same book was based on 1 in. = 25.4005 mm and 1 meter = 49.37 in. (still standard in surveying).

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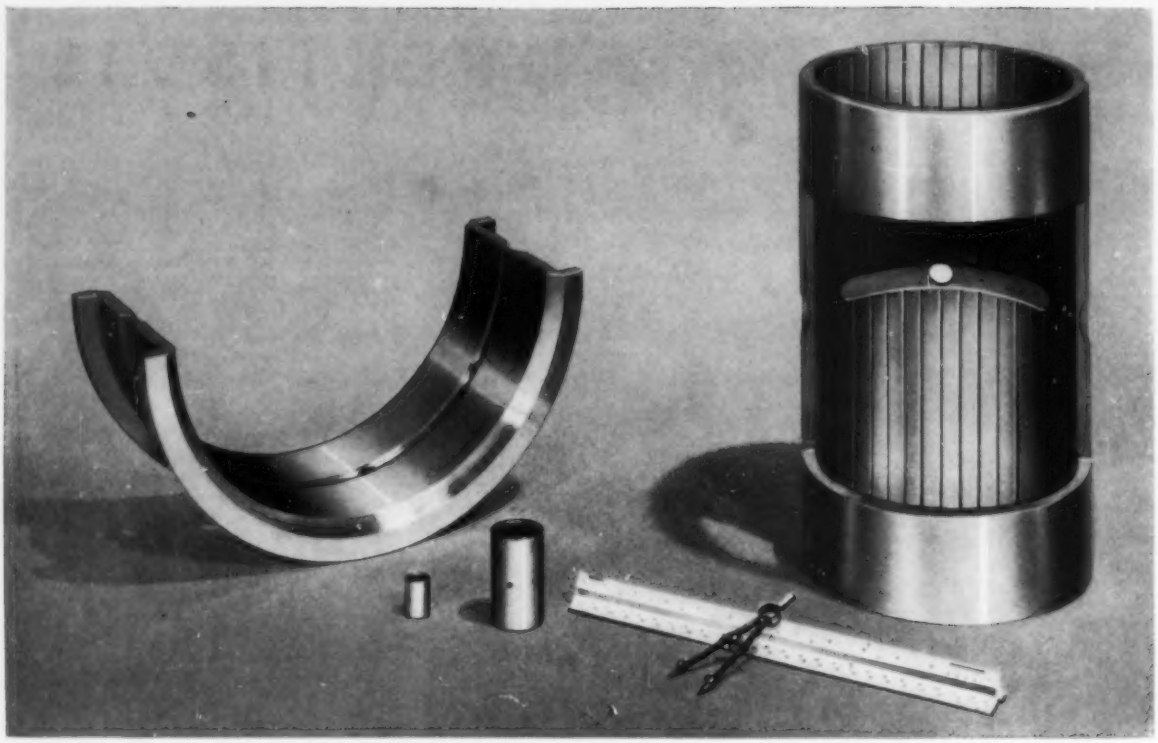

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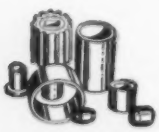

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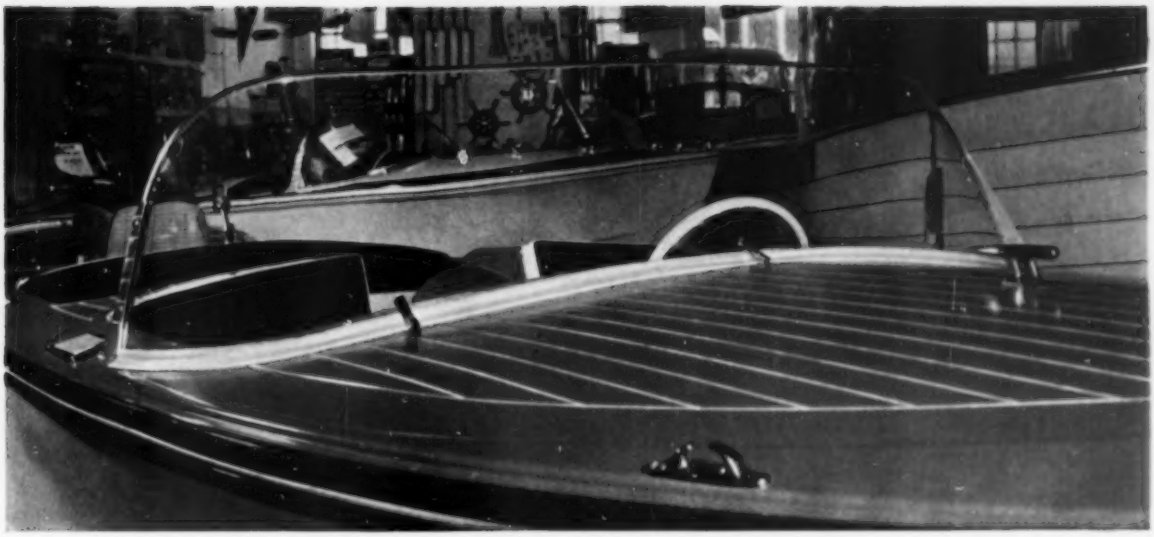

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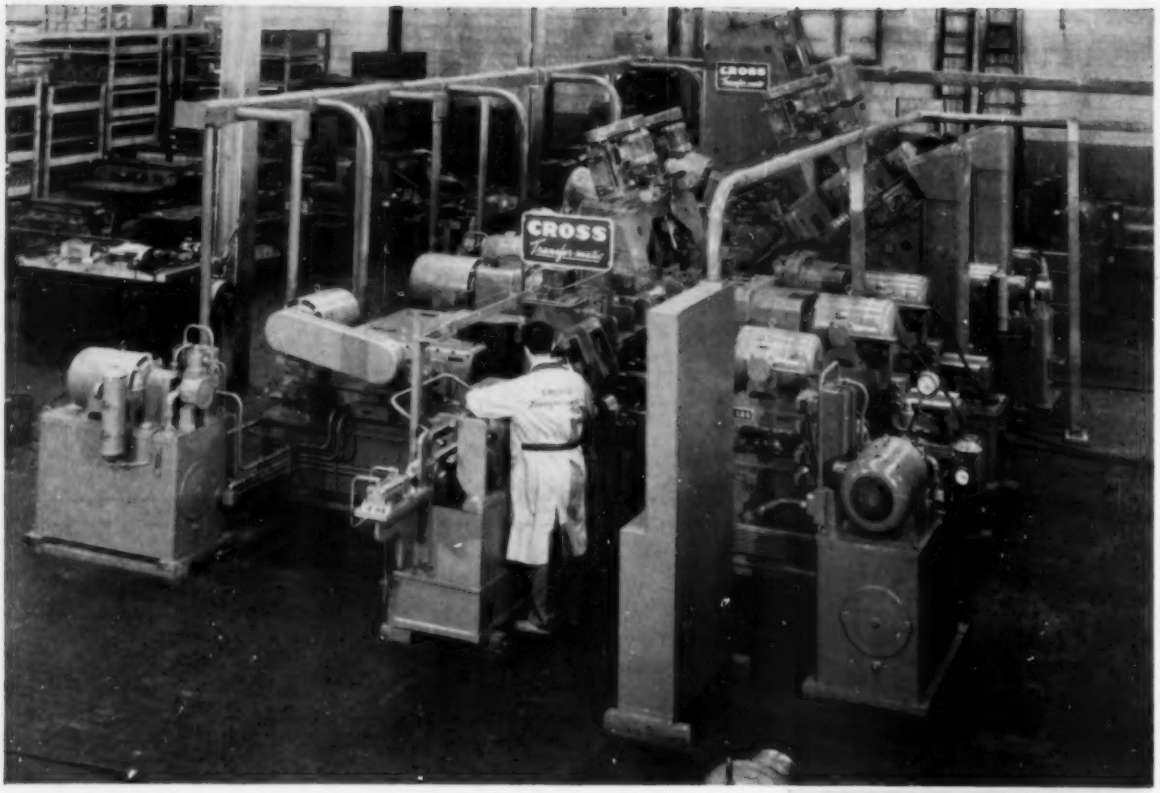

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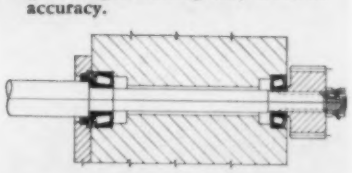

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